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The Eighth Annual Convention of The American Society of Civil Engineers.

(Special Correspondence of Engineering News)

PHILADELPHIA, June 14th.

The forenoon was spent in sight-seeing, most of the members visiting the Exposition. In the afternoon there was an excursion on the Deleware River, arranged by the American Dredging Company who kindly placed at the disposal of the Society their large and powerful tug, "Lightening." The tug left the wharf with a large party on board at 2.20 P. M., and after a short run up the river returned to Cramp's Dry Dock, the first object of interest which it was intended to visit, arriving there at 3 P. M.

This dock was built by the Philadelphia firm of Messrs. Smith & McGaw, and from Mr. Smith, who accompanied the party, the following particulars were obtained: The dock will take a vessel 450 ft. long; it is 111 feet wide on top, 45 feet wide on the bottom and contains 20 feet of water at ordinary stage of water in the Delaware River. It is built under the patents of Mr. Jas. E. Simpson, who superintended the work of construction. It required the driving of over 7000 piles and the use of immense quantities of timber and planking. Its cost, with the pumps and engines, was about $250,000.

The pumps are four in number and are built on the centrifugal principle, from the designs of Wm. C. Hibbard, of the Atlantic Works, Boston. Similar pumps are used in Portland, Me., Boston, Mass., Brooklyn, N. Y., and Wilmington, Del. The capacity of those at this dock is 30,000 gallons each per minute, making a total of 120,000 gallons of water that can be moved out of the dock each minute, when all four are at work. The engines, two in number, which run these pumps, are of 300 hose power. The construction of this dock was begun Sept. 20, 1875, and the first vessel was docked May 22, 1876. A model of a similar dock is to be seen in Machinery Hall, section E, 40, opposite the great Corliss engine. The following notes on the construction of this great work may prove of interest to the readers of the NEWS:

Work was begun by driving a row of piles on the north side of the dock, (the up-river side) for the permanent work; after these were capped with yellow pine timber, a coffer dam, 97 ft. long was built, as follows: three rows of 44 ft. piles were driven and waled; then three rows of spruce sheet piles 32 ft. long, 4 in. thick, tongued and grooved, and extending about 500 ft., were driven. Whilst this was being done the excavation was carried forward on the land end, with carts. Five rows of white oak piles were then driven round the dock, the water pumped out and the excavation carried to the bottom. As fast as the excavation was down to the proper depth, the foundation piles were driven and capped longitudinally; cross floor timbers were laid, drains established and the bottom of the dock floored, and upon this floor were set the keel and bilge blocks. Whilst the lower end of the dock was being finished the Messrs. Cramp built the iron gate in place. This gate resembles the hull of a vessel of very narrow beam and sharp at both ends. These ends set into great grooves in the sloping sides of the dock and are pressed against the sides of the grooves by the water outside. Rubber packing is used, and so tight does the gate fit that there did not seem to be a pailful of water in the dock. When it is desired to open the gate, water is first let into the dock from below by water gates; the water is then pumped out of the gate, which rising out of the grooves, is swung round, and the dock is open. The reverse process will close the dock. Around the abutments at the entrance, and below them, there have been placed great quantities of concrete; there are also six cut-offs of spruce sheet-piling driven across the dock and up the sides to secure against leakage.

A vessel was in the dock at the time of this visit.

After leaving Cramp's dry dock, the tug steamed to where one of the Company's Improved Grapple Dredging machines was at work, and after a short stay proceeded to the other side of the river, and towards Philadelphia, where the American Dredging Co. had at work a Shaw's Patent Gunpowder Pile Driver, the inspection of which was the special object of the trip. The driver was an object of great curiosity to those who had not previously seen it. It worked well and very rapidly. The following note regarding this machine is taken from the catalogue of the American Dredging Co:

"This powerful machine has been in practical and successful operation four years and been found most economical and efficient. By it, a pile forty feet long and fourteen inches in diameter, may be forced its entire length into firm ground, in one minute. by the successive explosions of cartridges composed of an ounce to an ounce-and-a-half of common blasting powder, without the slightest injury to the pile; obviating entirely the necessity of banding the head of the pile, before it is driven. There is no blow or concussion, as between solid substances, in the application of the force to the pile; the power is transmitted to, and acts upon the pile through the medium of an intervening stratum of air; and hence it partakes of the character of hydraulic pressure, applied with suddenness and rapidity, *forcing* the pile into the ground, instead of *pounding* it down, as by the old process.

The perfectly sound condition in which the head of the pile is left after driving, secures a greater sustaining power than is possible by the ordinary process, and renders it less liable to decay.

It is easily operated by the working-crew of an ordinary steam pile driver; greater penetration is secured, with much greater ease than by that process; no banding nor protection whatever is required for the pile head; no loss of any portion of the pile is occasioned from its injury, and the pile is infallibly guided "home" without assistance, with a saving of time and avoiding all risk of injury to workmen in this respect; while the rapidity of its action, coupled with the enormous pressure of its "blows" is believed to be unequalled by any other process."

Some account of the American Dredging Company, its size, resources and work will likely interest the readers of this paper. It has a paid up capital stock of $500,000, and owns property to the amount of $600,000. It owns and operates 14 steam dredges with the usual compliment of scows, four tugs, four gunpowder pile drivers, and still has to hire various kinds of plant to carry on its extensive works. The company operates mostly in Delaware River and Chesapeake Bay, but are also doing work in Florida, Georgia and Maryland; it also manufactures various kinds of plant for sale, and has just finished and shipped a grapple dredge of a capacity of 2500 cubic yards per day, for the government of Venezuela. At present its principal business is to fill and reclaim low lands and make harbor, river and dock improvements, in which operations it has driven many thousand piles about this city by the gunpowder process and is now using this process entirely.

In the evening the society held a business meeting in the hall of the Franklin Institute. The attendance was very large and much discussion of important matters was had. The meeting held till a late hour and adjourned till Thursday, P. M., at the call of the president.

THURSDAY, June 15th.

The Convention was called to order by the Chairman, Mr. Thomas C. Clarke. A paper on the "Erection of the Verrugas Bridge," by L. L. Buck, published in the regular proceedings of the society, was presented by Mr. Virgil G. Boge, and received with much interest by the members. G. S. Morison, then presented a paper on the "New Portage Bridge,' which was published in the January proceedings,—[as we hope to be able soon to publish these papers in full in the NEWS, the remarks offered on them are omitted.—ED.] Mr. W. J. McAlpine was then called upon to contribute to the discussion of a paper by Clemens Herschel, upon "Waves of Translation that emanate from a Submerged Orifice," published in the July, 1875 Proceedings of the Society by that gentleman. Gen. T. G. Ellis made some remarks on the subject.

An invitation to visit the Stevens Institute at Hoboken, was then read, after which followed a discussion upon Gen. T. G. Ellis's, paper on the "Description and Results of Hydraulic Experiments with Large Apertures, at Holyoke, Mass., in 1874," published in the February Proceedings of the Society. Mr. Clemens Herschel offered a few remarks commendatory of the paper. Gen. Ellis then made some remarks upon a criticism of his work published in one of the scientific papers. His remarks demonstrated the extreme care with which his experiments were made, and only added testimony to the great reliability of his results. He even went so far as to carefully find the exact value of the force of gravity at the place where he experimented.

A report of a committee upon an "Uniform System of Gauging Streams" was then submitted by Gen. Ellis, the chairman. The sense of the committee was expressed in the remark that no uniform system could be established, as the method of gauging must be adapted to the conditions of each stream. The report was signed by but two members of the committee of three. Then followed remarks upon "Notes and Suggestions upon the Croton Water Works and Supply for the Future." Mr. J. J. R. Croes stated that it was not safe to depend upon inadequate masonry aqueducts set in embankments where the embankments are depended upon to resist the pressure, as they have all settled and cracked longitudinally throughout great lengths of such conduits. He recounted several instances of these failures, and his opinion was, that the masonry should be strong enough to resist the whole pressure.

The paper entitled "Notes on the Improvement of the Mouth of the Mississippi," by W. M. Roberts, published in the December, 1875, proceedings, was then submitted. Capt James B. Eades not being present, Mr. E. L. Corthell, First Asst. Eng. So. Pass Jetty Works, gave an account of many interesting matters connected with the work. It was a matter of remark that this was the anniversary of the commencement of the jetty improvement. Mr. Corthell's paper consisted of an extended series of tables showing a great number and variety of very interesting facts connected with the important national work under his superintendence. His remarks showed the great result obtained in one year, and gave rise to a conviction that it is a question of no very long time when we shall possess a magnificent entrance to our greatest river. This great question about which so many theories have been advanced is fast being settled by experiment.

The next paper, which was read by the secretary, was upon the same subject by Capt. C. W. Howell, of the U. S. Engineers, showing the failure of the Jetty System, arguing that such would be the case from the facts that have been obtained in the case of certain foreign rivers. A reply to this paper was then made by Col. W. Milnor Roberts, the author of the original paper under discussion. He corrected many of the statements of Captain Howell, and made a forcible reply to that gentleman's paper. He strongly referred to the fact, above noted, that the question of the success of the Jetty System at the Mississippi is fast being settled by experiment and *not* at the expense of the Government.

It was stated that Capt. Eads in the past year had changed the depth upon the Mississippi from 7 or 8 ft. to nearly 18 ft., and that several of the largest ocean steamers had recently passed in and out. Col. Roberts read an extended and very valuable communication upon the subject of the Mississippi Jetties which he had prepared without reference to the discussion of his paper. This additional paper showed a very extensive and searching knowledge of the subject. He was followed by Gen. J. G. Barnard who was connected with the surveys at the mouths of the Mississippi almost from the commencement of the agitation for the improvement of the entrance to the river, and for many years afterward. He recounted the history of the Canal Project for accomplishing the object arrived at. He became of the opinion that although a canal might be built, it would not furnish the desired relief. He was satisfied of the greatly superior desirability of an open river mouth. This conviction gained ground amongst the people till it became evident that it was demanded that the experiment of an open river mouth communication should be tried. Then followed an account of the early efforts in making this kind of improvement. The first was by dredges and was followed by an attempt to build jetties, These efforts were followed by various experiments and theories till the time of the present experiment which gives such hopeful promises of success. The speaker long ago had no doubt that jetties could be constructed and maintained. He contributed some further facts regarding the history of this discussion and then closed.

After a recess of an hour the "Report of the Committee on Tests of American Iron and Steel, " W. Sooy Smith, Chairman, was submitted. Mr. Smith appealed to the society to exert itself to secure a suitable appropriation to carry on the test for another year. There were facts cited to prove the *necessity* of a continuance of these experiments, and a statement was made tending to show that there was a great deal of opposition to this work, that the very existence of the Board was threatened.

Mr. Chester said that he was assured by private information that Congress was much better disposed towards the subject than was imagined, and he therefore moved that means be taken to provide the society with more extended and reliable information about the matter.

Col. Merrill here invited the members to come to the wharf at the foot of Market St., and examine the mechanism of a torpedo boat at their convenience.

Mr. Chester's motion was passed and the report of the chairman on Tests of Iron and Steel was accepted.

Mr. Clemens Herschel reported "On the Metric System of Weights and Measures."

Mr. Coleman Sellers opposed the adoption of the Metric System by compulsion or law, in a well chosen speech and brought forward many facts to support his position. He favored the legalizing of the system, but thought that the pressure for its adoption should come from the people and not be forced upon them.

Prof. J. E. Hilgard, of the Coast Survey, followed Mr. Sellers. He stated that it would be dangerous to the introduction of the System to urge a compulsory law upon Congress. His reason was was that it was very difficult to get any attention to the matter from the members of Congress. He believed it was best to use it and teach it as far as we could till those who had learned it should become legislators, when something could be done.

Mr. Herschel offered two resolutions as follows: Resolved that the Society appoint a committee of five to draft a memorial to Congress concerning this matter, and: Resolved that the American Society of Civil Engineers will forward by all legitimate means the adoption of the Metric System in the government offices.

A motion was made by Mr. Chester to vote on these resolutions by letter ballot.

Mr. Robert Briggs and Prof. DeV. Wood, opposed the passage of the motion on the ground of a want of discussion. Mr. Herschel urged that the adoption of the motion would favor the most complete information of the individual members upon the subject. Mr. Briggs still opposed the motion. Mr. Chester then withdrew his motion.

A motion was then adopted to appoint a committee of five to consider these resolutions and report at the next Annual Convention.

Here followed a report on Railroad Accounts and Returns by W. P. Shinn, in which was given valuable information and principles of such accounts and returns. He believed that such accounts and returns should be made upon the same principle by all the various roads. He set forth an exceedingly simple and comprehensive set of headings or principles upon which such accounts and returns could be kept. The paper will be found to be of great value to those who desire information upon these matters. A committee was urged for the consideration of the adoption of a uniform system of keeping these accounts and returns and a consultation with State Rail Road Commissioners looking to the same end. The appointment of this committee was opposed by Mr. Chas. H. Fisher Chief Engineer of the N. Y. C. R. R., on the ground that State Rail Road Commissioners are regarded as hostile organizations by railroad companies, and that if any thing was done the roads should be consulted.

Mr. Chas Latimer, Chief Engineer of the Atlantic and Great Western, gave a statement of his method of keeping such returns which was of a very satisfactory nature and surprisingly complete, whilst very simple.

Mr. Chas. H. Fisher, Ch. E. of the N. Y. C. R. R., moved the appointment of a committee of five by the chair to consider this subject.

Mr. Mendes Cohen, Chief Eng. of the B. & O. R. R., urged the full consideration of this subject.

Col. W. Milnor Roberts followed with remarks upon the same subject.

It was found necessary that Mr. Fisher's motion be changed to a resolution advocating the appointment of the committee he desired.

Mr. Ashbel Welch gave an additional report on the "Form, Weight, Manufacture and Life of Rails." He set forth some interesting experience on the line between Philadelphia and New York where rails had withstood excessive use for a great time. The report was accepted.

The report on the Nomenclature and Classification of Masonry by J. J. R. Croes told of progress made, and urged more general assistance and replies from the members. Adopted.

Gen. T. G. Ellis read the report of the Committee on the Failure of the Worchester Dam, Mass. The dam failed because of leakages and their gradual increase, till they at last rapidly undermined the works, causing them to cave in and break down in large masses. Accepted.

Mr. Wm. J. McAlpine followed with some remarks and promised a communication in which should be set forth the facts which he has collected in his work of restoring the dam and rebuilding it.

The Report on the Resistances of Railway Trains was read by Mr. Wm. P. Shinn which consisted of a communication from Mr. P. H. Dudley, of the L. S. & M. S. R. R., on his experiments with the Dynograph. These were very careful experiments but the communication, though of usual length, was only long enough to create a desire for further information from the same source.

Mr. Chas. H. Fisher moved the immediate printing of the communication of Mr. Dudley, and that it be circulated amongst the members, which motion was adopted.

Mr. W. Milnor Roberts moved a graceful tribute of thanks to the Philadelphia members for their numerous courtesies. Also to the Judges of the Centennial for the use of their hall, and to the Chairman, who so successfully and acceptably presided at the meetings.

A motion to adjourn was then adopted.

In the evening the society attended a reception given at the hospitable manson of Fairman Byers, Esq., No. 202 West Rittenhouse Square, where several hours of the most enjoyable and delightful social intercourse were passed and from which the members came away filled with pleasant memories of the many courtesies that had been extended to them in the Quaker City in this centennial year.

FRIDAY, June 16.

In response to an invitation from Frances H. Saylor, Esq., Superintendent and Engineer of the Delaware and Bound Brook Railroad, a large number of the members assembled at the North Pennsylvania depot by 9:30 A. M., where they found an elegantly appointed train, in charge of Mr. Saylor, in waiting to convey them over the New York and Phialdelphia New Line, to Jersey City and return.

Among the excursionists we noted the presence of Capt. A. Vendee Howen, of the Russian Artillery Service; John E. Jcehy, C. E., Centennial Commissioner from Switzerland; Emil Burgin, C. E. Switzerland; Hon. Wm. J. McAlpine; W. Milnor Roberts, Vice-President of the Society; Maj. Gen. J. S. Barnard; S. S. Smedley, Esq., City Eng. Philadelphia; A. L. Holley, C. E., besides many other gentlemen, will known in professional and scientific circles.

The train was composed of five passenger coaches, with smoking and baggage car attached, and was drawn by Engine No. 103, one of the finest of the Baldwin Locomotive Works manufacture. The coaches were built by the Harlan and Hollingsworth Co., and by Messrs Bowers, Dure & Co., of Wilmington, Delaware, in the most luxurious style interially, and were provided with all the latest appliances for the comfort, convenience and safety of passengers.

By the recent completion of a section of 47 miles, the N. Y. & Phil. New Line Railroad, now furnishes a new and independent route between the great metropolitan cities of the East, 88.4 miles in length, and traversing a most beautiful, productive, and populous section of country.

The road is one of the best constructed in the country; it has very few curves; its steepest grade is 36 feet to the mile; it is laid throughout with a double set of tracks of steel rails, weighing 66 pounds to the yard; the track is stone ballasted; the bridges are all of iron and built in the most substantial manner; grade crossings have been avoided as carefully as possible; there are no very large turns in cities in its route; it therefore presents unequalled facilities for fast travelling and offers special inducements to the through traffic between the cities that are its termini.

Another, and very important feature introduced on this road, and one which any person who is accustomed to traveling between New York and Philadelphia can appreciate, is the use of anthracite coal in the engines, thus doing away with the intolerable nuisance of the blinding and suffocating clouds of smoke and cinders that render this trip by any other route so uncomfortable. The passenger station in Philadelphia is at Berks and American streets, and is reached from Chestnut St. in twenty-five minutes by the street cars on Third street and on Fifth street, and also by the Union Line up Noth street; the station in New York is at the foot of Liberty street, North River, and the ferry of the Central Railroad of New Jersey is used.

Starting at the appointed time, the train was first stopped at the Neshammony Bridge to permit of an examination of that structure. It is built of iron and stone, is of six spans of 150 feet each and 25 feet deep, with approaches 63 feet long each, and 10 feet deep. It is a deck bridge of the double inter-section system, and together with all the other bridges on this line was erected by J. H. Cofrode & Co. of Philadelphia. An examination of the workmanship of these structures discloses careful and conscientious work throughout, and we may add here that at a snbsequent visit to Mr, Saylor's office at 407 Walnut St,. Philadelphia, we were favored with an inspection of his note books, maps, plans and other records of information regarding the construction of the road, and can bear testimony to their being perfect models of their kind.

The Delaware Bridge at which the next halt was made, is an iron structure, which together with the approaches is 4300 feet long. There are nine spans of varying lengths, all 26 feet 8 inches deep. The approaches are of trestle work and are now being replaced by embankments. The height of the rails above the river is about 70 feet. This bridge was constructed, from the foundations up, in five and a half months, under the supervision of Davjd McN. Stauffer, C. E.

Morris Mill-dam Bridge, of four spans of 108 feet each

by 12 feet deep was inspected and a further short run brought the party to the Mercer & Somerset Railroad Crossing which has a local notoriety as being the point of dispute between the Pensylvania Railroad Co. and the Bound Brook Railroad Co., the particulars of which were reviewed shortly and clearly for the benefit of the excursionists by Mr. Saylor.

The company were then treated to a "dash" of 15¾ miles in 18 minutes. at which high speed the excellent character of the road was fully tested to the satisfaction of all present. After an examination of the Rantan Bridge, the only "through" one on the line, a structure of three spans of 150 feet each by 25 feet deep, the train ran to Jersey City and the party crossed over to New York. Two and a half hours were allowed before the return trip. Some of the members visited the Stevens Institute of Technology at Hoboken at the invitation of Prof. DeVolsen Wood; others spent the time in New York, while the larger portion made their way to their homes or places of business. In fact, this closed the Eighth Annual Convention of the American Society of Civil Engineers, a meeting ever to be remembered in the annals of ths society for its many pleasant associations and interchange of courtesies, and for the further extension of the influence of the civil engineering profession in America.

The return trip was speedy, comfortable, and rendered very pleasant and enjoyable by the conversation of the host of the occasion and of the gentlemen who returned to Philadelphia. The depot was reached on time, and the party broke up, after extending the most cordial thanks to Mr. Saylor for his unremitting care in providing for their comfort and entertainment throughout the trip.

J. B. D.

Rural Railroads.

(From Fleming's "Narrow Gauge Railways."

In France a plan has been set on foot for the construction of what are to be called "Rural Railroads." The project was first broached by M. Chambrier. a well known civil engineer, who has devoted much time and attention to it, The proposition is for the construction of narrow lines of "rural railroads," or a width of one metre only, instead of the usual gauge of one metre and a half—along the wide space which every traveller in France must have observed on the side of almost every high road. Now, at present, the ordinary railroads transport heavy goods at the rate of 3 or 4 centimes, or less than a cent per ton per kilometre; but only under condition of allowing a large accumulation to take place, and consequently a great loss of time at stations, and then sending off the whole in a lump by one slow heavy goods train. Now these "rural railroads," economicolly constructed and without stations, or depots, or accommodations of any kind, profess to be able to replace ordinary carriages, without any delays, at two or three times less than the present cost. They will connect the small towns and villages and manufactories all over the country. and carry off their produce, agricultural or other, as it is ready for transport. For their construction there will be no need of "Acts of Parliment," or compulsory appropriations, or surveys, or other expensive preliminaries, any more than for costly contributions of any kind along the line. All that will be required will be the "concession of the roadsides" for the purpose of the Conseil-Generale of the Department, with the authority to modify here and there the inclines, when too steep. Simple receiving offices may be established at village stores, or the owner of goods may bring them to the train himself and accompany them to their destination, paying his fare on the way, just as in an omnibus or tramway, without the cermony of ticket taking or other impediment. The expense of laying down such "rural lines" will not exceed 25,000 france per kilometre, instead of 100,090 francs, which is the case even on the most economically constructed ordinary roads in France. The estimate also of the proceeds of snch lines based on a rate of carriage of 25 centimes per ton per kilometre, and on the road traffic of goods and passengers, seems to be fairly remunerative in a financial point of view, as an investment, exclusive of the general advantage to agricultural interests to be expected.

Marion, Ind., is to have Water Works at on expense of $30,000.

Annual Meeting of the American Institute of Mining Engineers.

(Special Correspondence of Engineering News.)

PHILADELPHIA, June 19.

The meeting was called to order by the President, Mr. A. S. Holley. Dr. R. W. Raymond, past President of the Institute and Commissioner of Mining Statistics, was chosen Chairman and Mr. Holley, Secretary.

The discussion on the topic for the evening, Technical Education, was opened by the chair. After tracing the growth of the discussion in hand, he spoke of two classes of men to be technically educated; those who design to become engineers, so-called, and what are known as working men.

Division of labor and perfection in one branch of a trade, although in the interest of the employer, interfered largely with the education of working men. He discussed at some length the question of practical training before entering school, favoring it in some cases and thinking it disadvantageous in others.

Mr. Thos. C. Clarke contributed a valuable paper on The Education of Civil Engineers, in which he took the ground that civil engineering included all scientific construction. The question is as to how much of practical training, and how much school instruction shall be combined in the education of the civil engineer. He was in favor of a scientific course as a preliminary to practice. He recommended the student to pursue a scientific course until 18 or 20, and then to practice his profession for several years; after which, to return to his books or not according as he belongs to one of two classes; viz., the particularly scientific or philosophical class, or the executive class. The engineer above all things should first acquaint himself with scientific methods, that of collection of data, arrangement of it, study of it and deduction of final results.

Capt. Douglas Dalton, of London, being called upon, gave an account of the methods provided by the Indian Government for the education of its own engineers. A college for engineers has been established at Coopers Hill, near London, and although the theoretical training is good it is supplemented with very little prrctical training. As a consequence, when the graduates were put to practical work, in India, it was considered that the cost of their blunders made this method of education very expensive.

For workmen Sir Joseph Whitworth has set apart $1,000,000, to provide for scholarships to be given to workmen who distiuguish themselves in a technical examination.

Dr. Wedding, of Berlin, being called upon by the chairman, stated that schools were provided for the brighter workmen who were selected by their employers and educated without expence to themselves. Academies are provided for eight branches of technical education, and to enter these a high school education is necessary. He endorsed the course indicated by Mr. Clarke.

Mr. Coleman Sellers, of Philadelphia, insisted upon drawing as one of the *fundamental* things to be taught in our public schools. He also insisted upon a change in the course of instruction so as to include at least *something*, however crude, upon practical matters. He strongly supported Mr, Clarke.

Mr. Pechin, of Dunbar, Pa., considered as liberal an education as possible very essential. The man preparing to manage a blast furnace should follow his liberal education by a technical education and that by thorough practice in all departments of his work, from the bottom up. These ideas were well supported in a strong speech.

W. Milnor Roberts obened with an account of technical education in Philadelphia fifty years ago, paying a noble tribute to the Franklin Institute and its work. Our present engineering schools were likely to fail because they do not make engineers, often spoiling men who would have succeeded in a different direction. General education should precede technical studies which should be pursued in reference to that department of engineering which the student intended to follow. The essential thing is *good judgement*. Some preliminary education is insisted upon in all cases. Practice, when possible, should be combined with theoretical instruction. From the nature of engineering work this was generally impracticable. Our technical schools give ample preparation for entrance into the engineering profession.

Mr. Ashbel Welsh said that his written paper had been anticibated. After entertaining the meeting with many anecdotes which cannot be reproduced without the aid of the speaker, he closed with a powerful plea for *integrity* in the character of the engineer.

Prof. Rogers, of the University of Pennsylvania, then spoke from the teacher's standpoint. He endorsed the broadest possible culture. Technical schools should teach underlying principles; too many subjects are attempted; fewer things well mastered would be better. He objected to breaking up the course by a year or more of practice, and should give only that practice necessary to fix principles. Schools should teach only that class of subjects that cannot well be learned outside, in any reasonable time or from the nature of the subject. He adduced his own experience in support of his position.

Mr. A. L. Holley advocated sending the high school graduate to practice before sending him to the technical school.

After the reading of Mr. Holley's paper the meeting adjourned to 10 A. M., Tuesday.

TUESDAY, June 20.

Pursuant to adjournment the meeting was called to order by Dr. Raymond, and the discussion of Technical Education resumed. Althongh much was said last evening the subject seemed by no means exhausted.

Mr Eckley B. Coxe of the Centennial Committee of the Institute, gave many valuable ideas. He considered Engineering Degrees a humbug.

Mr. Wm. P. Shinn, A. S. C. E., considered the science of accounts as a part of the education of engineers. More works were a financial rather than a physical failure.

Prof. Eggleston of Columbia College, N. Y., advocated as extended culture as possible. A continued course of Mathematics and Language was desirable and he recommended the German Language if only one could be taken. He firmly believed in introducing the commercial side of all subjects.

Prof. Robert Hunt, of Troy N. Y., was satisfied that in the case of metallurgical students, practice should precede technical school instruction. He thought it would be advantageous to the proprietors to have students come into their shops and places of business under a teacher. They could act the part of overseers and add much to the efficiency of the works.

Prof C. O. Thomson, of the Worcester Free Institute, Mass., said the experience of their school argued the desirability of combining theoretical and practical instruction. His contribution was exceptionally valuable.

Mr. P. H. Dudley followed with a paper on the Education of Railroad Engineers.

Mr. J. B. Davis, of Michigan University, made a few remarks on the phases of the subject presented at that institution.

Mr. Ferry J. Slade, of the Trenton Steel and Iron Works, thought it useless to introduce practice into the schools, and that students should not enter works until they came to stay.

The discussion was summed up by the President and the meeting adjonrned.

Before adjourning notice was given that the contributions to this dlscussion would be publishes in full.

J. J. D.

Business Meeting, Excursions, Reading of Papers ending with *conversasione* at Headquarters, No. 1,100 Girard Street, Thursday evening, will continue during the coming week.

Fort Wayne Water Works.

Nessrs. Lane & Ryall, the engineers employed in the investigation of the subject of the proposed water supply of Fort Wayne, Ind., have reported adversely to the use of wells and filtering galleries for a supply; the City Council are at loggerheads in the matter, and a resolution to pay off Mr. Lane, Consulting Engineer, on the plea that his services were not required any further was tabled by a vote of 12 to 5.

Meantime the council have accepted the invitation of Mr. J. A. Richardson, of the Holly Water Works, to witness a trial of the Holly system, in Indianapolis on the 4th of July next. Indianapolis is a wide awake place and if the Fort Wayne people after all *should* be entrapped into the adoption of the Holly system, they may console themselves with the thought that a great many other cities with populations as intelligent as that of Ft. Wayne are willing to be found in the same fix.

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GEO. H. FROST, - Editor and Publisher.

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and of the

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CONTENTS:

Eighth Annual Convention of the American Society of Civil Engineers	201
Rural Railroads	203
Annual Meeting of the American Inst. of Mining Engr's.	203
Fort Wayne Water Works	203
Iowa City Bridge	204
Surveys of Public Lands	204
South Pass Jetties	304
Pile Driving Apparatus	205
Researches on Ebullition	205
Notes	205
The Late Ransom Gardner	206
New Publications	206
Proposals for Contracts	206

THE IOWA CITY BRIDGE.

Since the publication of the communication in the NEWS of June 10, upon the bids for the superstructure of the Iowa City Bridge, some papers have been put into our hands bearing upon bid No. 10, of the Indianopolis Bridge Co., Indianopolis, Ind. The bid of this company is stated, in the article above referred to, to have been "Arch, $32,00 per lineal foot." "Compression at springng line 13,800 lbs per square inch; at crown 12,300 lbs per square inch." The article also gives the general requirement "The bridge to carry a moving load of 2,000 lbs per lineal foot and not strain the material of the bridge above one-fourth of its ultimate strength."

In reference to these points we have before us;

First: The letter of A. J. Hershire, Auditor, Johnson Co., dated Iowa City, April 19, which says, "Length: 2 spans of 150 ft. each from centre to centre, * * * Load: 200 gross tons evenly distributed without danger to the structure.—1,400 lbs. per lineal foot, factor of safety one-fourth, is suggested by the bridge committee."

Second: Specifications for a proposed arch bridge from the Indianapolis Bridge Co., giving rolling load 1,400 lbs. per lineal foot, with a factor of safety of 4. Accompanying these specifications is a strain sheet, vouched for as a copy of the original one. This sheet shows the stresses on all of the pieces, with the number and the sizes of the parts. The compression at the crown is given as 154,687 lbs, and at the springing 174,795 lbs. The assumed weight of the bridge is 800 lbs. per lineal foot, rise of arch 20 ft. The reader can easily verify these stresses for himself. The arch has two 10 inch channel bars, 23 lbs. to the foot, with a plate 20 in. wide, 5-16" thick at the springing, and ¼" thick at the crown. The section at the springing being therefore 20 sq. inches, the thrust per square inch is 8,740 lbs. The section at the crown is about 18.8 sq. inches, which gives a thrust of 8,813 lbs. per sq. inch. The lower chord was two bars ½"×11", or 11 sq. inches, to resist a tension of 154,687 lbs. or 14,063 lbs. per sq. inch.

Third: The letter book copy of the bid of the Indianopolis Co., which reads "We propose to furnish all material and labor, and complete ready for travel the superstructure for a *Wrought Iron Arch* Bridge according to the plans, specifications, &c., herewith submitted, for the following prices per lineal foot, viz:

Arch, plan No. 1, for $27.30 per lineal foot.

Arch, plan No. 2, for $24.50 per lineal foot.

With all iron floor beams, 1 to each pannel, as discribed in specifications, $2.00 per lineal foot extra."

Plan No. 2, refers to another plan of a lighter bridge which had no accompanying diagram nor any specific load, but the dimensions of which were given, and a comparison was asked.

We are quite at a loss to see how the figures we have just given, which to our view are within the requirements, can be reconciled with those quoted from the article of June 10. There is a most decided discrepancy between the moving loads called for in the two cases. Mr. Irish puts it at 2,000 lbs. and Mr. Hershire at 1,400 lbs. per lineal foot. It is possible that, by putting the heavier load upon a bridge designed for the lighter one, something like these stresses might be realized, but such a treatment would be unfair to the designer.

There is one other point to which we wish to allude, and that is "The committee having selected bid No. 9, notified the company to bring the structure to the above requirements which the agent contracted to do at the price in his bid." This seemes to us to be giving an advantage to the man who made a design which did not come within the requirements and whose bid was low, inasmuch as he is afforded an opportunity to modify his design after the bids are opened. Is not this really putting in a new bid? And, if bids which fall below the requirements are not to be ruled out at once, ought not all bidders to have an equal chance to figure again?

SURVEYS OF PUBLIC LANDS.

Under the present system of surveying the public lands, large tracts are blocked out in the offices of the surveyors general and recommended for sub-division into sections. Most of the available land in this country was, years ago, surveyed, or at least platted, and entered for sale in the several land offices, and much that remains is remote from settlement, or utterly unfit for use of any kind. Still the usual appropriations have been voted and the same system of poor, or even fraudulent, surveys, by contract at so much per mile have been kept up. If any person wishes to know how contracts for surveys are obtained, and what interest the surveyors general have in the letting them, over their regular salary, let them try to get a contract; if they wish to know why there is so little reliable surveying in the country, let them follow a party which is surveying prairie or mountain lands by the mile—the more miles per day the more dollars—and they will soon come to the conclusion that surveying is *not* an exact science, but rather a very loose practice, in the far away regions of the West, at least.

The spirit of investigation that has prevailed in this country for some time past could not well overlook so large an appropriation as that of the Public Surveys, and that occasion for improvement was discovered is evident by the following:

"Washington, June 15.—The House Committee on Appropriations yesterday decided to abolish the existing system of surveying the public lands. It is now proposed to give the Commissioner of the Land Office a sum in gross to be expended first in the survey of land suitable for cultivation without irrigation, and second, those with irrigation. He will be held responsible for the proper carrying out of this design. This will do away with the useless expenditures hitherto made for the survey of barren mountains and sterile plains. The committee have decided to recommend appropriations for the Hayden, Powell, and Wheeler expeditions, but in each instance have cut the estimates about thirty-three per cent.

Referring to the decision of the Committee of Architects in the case of Mr. Cochrane, of this city, the report of which was given in ENGINEERING NEWS, May 20th, the following is from *The American Architect and Building News*, of Boston:

The decision of the committee is unquestionably judicious, as is the suggestion by which it was accompanied, that the unimpeachable course would have been for the contractors to have themselves employed draughtsmen to make copies or tracings of the drawings at their expense, with the permission of the architect. The question involved, of the limit of the work which may be expected of an architect, is one which is likely to become more and more important as his duties are becoming more complex, and exact more labor from him. There is no doubt that architects in this country spend on the average much more time and money in drawings for work of the same cost than they did years ago. The differences among architects in this respect are very great; but it is safe to say, that, for those who do their work with real care, the expense of carrying it on eats up from one-half to three-quarters of their commissions; probably the latter with most of those who have enough work to need any considerable force of subordinates. This is a matter which is quite inscrutable to clients, who seldom detect the difference between the architect whose office-work is done with minute and expensive faithfulness, and the one who throws it off hastily and cheaply. It is left out of the account by most people, who think that a five per cent commission must pay architects very liberally and even extravagantly. So it does many architects; but there are many others to whom with a considerable practice it barely gives a comfortable living. The trained eye sees the corresponding difference in their work at a glance; but the public does not. In this condition of things, it is quite desirable that somewhat more definite standards should be fixed for the amount of work which an architect ahould give. We are not of those who are anxious for an accurate commputation of all labors of an architect, and a closely adjusted scale of payment for everything. We think that the freedom of a professional relation is a wholesomer condition for him than the minute exactions of a mercantile tariff. But it would be an advantage if there were some better understanding than exists of the proper amount of his labor; one which should protect him, on the one hand, from the exactions of clients who often expect his commission to cover an unreasonable amount of work of which they do not at all understand the cost; and which, on the other, should secure to the client something more than the hasty and inadequate workmanship which is often rendered in return for his five per cent.

South Pass Jetties.

Captain J. B. Eads, who is building the jetties at the mouth of the Mississippi, has become involved in an unfortunate and unnecessary dispute with Major Howell, of the United States Engineers, who was with General Humphreys, one of the advocates of the Fort St. Philip Canal. The grant obtained by Captain Eads from the Government (one of the least objectionable that ever passed through Congress) stipulates that nothing is to be paid him unless he succeeds in securing twenty feet of water through the South Pass to the Gulf within the specified time. Now, Captain Eads declares that the work is going on in the most encouraging manner, that he has already got sixteen feet, so that the largest coasting steamers have been sent to sea over the bar, "on which scarcely eight feet of water could be found last year." Major Howell, on the other hand, declares in a published letter that there are only twelve feet of water at the South Pass, that the "nucleus of a new bar" exists in front of the jetties, that a shoal is making out to this nucleus, and that in short the jetties are doing no good. Against all this Captain Eads brings certificates from his engineers that Major Howell's statements are unfounded, and he protests against his enterprise being embarrassed by officers having no immediate connection with the work, and has written a letter to the Secretary of War, begging that any further interference on the part of such officers be prevented, and that instructions be issued to the inspecting officer authorized by the Jetty Act to furnish him directly with any information as to the result of the work he may need, and that he be ordered to report to the Secretary of War instead of to the Chief of Engineers. Whether this is desirable or not we do not know; but it is certainly a great mistake to allow engineer officers in the employment of General Humphreys, who is known to have no faith in the jetty system, to write letters to the newspapers ridiculing the experiment when the department of the service to which they belong stands in a judicial attitude to the undertaking. This, at any rate, ought to be stopped.—*The Nation.*

The Hudson River Tunnel Company, which has been delayed more than a year by injunctions, has again resumed operations at the shaft in Jersey City.

Pile Driving Apparatus.

BY HERR WEBER.

(Protokolle des Sachsischen Ingenieur Vereins,—Translated by The Institution of Civil Engineers.)

Nearly all the pile driving machines at present in use are adapted for operating on only one pile at a time; it is the object of this machine to place several rams under the control of a single steam-engine. The apparatus by which this is affected may be divided into three parts—the engine, the power-distributor, and the ropes or chains which lift the monkey. Any of these may be separated and fixed at varying distances and different levels. Any engine, with which driving bands can be employed, may be used to provide the motive power, the bands imparting it to a system of ropes or chains by which the rams themselves are actuated.

A light timber frame carries the power-distributor, which consists chiefly of a pulley, rotated by the driving band of the engine, and imparting motion to a poppet head running backwards and forwards on two timber bearers. An endless chain or rope passing over this poppet head communicates at the foot of the scaffolding erected on the spot where the pile is to be driven, with the machinery for lifting the monkey. The endless rope can be slackened or tightened by a lever, and moveable discs or pulleys, over which it passes, enable it to be adjusted in any direction required by the position of the pile. The third part of this machine consists of the ordinary monkey, lifting ropes, windlass and scaffolding; but a special arrangement is provided by which the drum can always be rotated, whatever position it may assume with respect to the power-distributor, whilst at the same time it is kept at right angles to the lifting rope, so as to prevent its slipping off.

This invention was used at Dresden on the Elbe, for fixing the piles of a quay wall 541.° yards long. The engine and power-distributor were placed on a platform, fixed to two pontoons coupled together, while attached to them by long raking timbers, which served also as foot-bridges, was a raft 114.8 feet long by 13.1 feet broad, on which the three pile-drivers with their machinery were fixed. On two of these the monkey was raised and dropped between parallel guides, but in the third an iron pole was fixed on the head of the pile, the monkey working up and down it through a hole in the center. The engine, power-distributor, and pile drivers required one skilled attendant each, in addition to which six or eight laborers were variously employed.

Of the total number of piles driven, four hundred and fifty-nine were main piles, and one thousand six hundred and thirty-four intermediate piles; the former were from 9.8 to 16.4 feet long and 7½inches square, the latter being from 9.8 to 27.5 inches square and 13 feet long. The main piles had shoes of wrought iron, made in four pieces, and were driven from 5 to 7 feet into a bed of rough gravel and stones; the intermediate piles were merely shod with sheet iron, and put down to a depth of from 3.6 to 3.9 feet. The work occupied thirty-two days, during which time 120,000 blows were struck, by rams weighing each 8.07 cwt., with a fall of 9.84 feet, a height which proved most suitable. This averaged 1,580 blows for every cubic metre of timber driven, or 242 for every square metre of the wall itself. The monkey was lifted 65.6 feet every minute, or 13.11 inches per second, showing that the work done by each pile-driver was as follows:—8,07 cwt. × 65.6 feet = 59,299 foot-lbs. = 1.8 HP., or a total of 5.4 HP. for the three drivers.

The steam-engine had a cylinder 10.23 inches in diameter, with a stroke of 15.75 inches, the pressure of steam in the boilers was 3 atmospheres and the expansion ⅓; the indicated HP. was 6.03, showing very little loss of power between the motor and the pile-drivers. The relation between the power at the windlass drums and the weight was as 1 to 19. The winding ropes, 0.6 inch in diameter, were of cotton, not hemp, and gave excellent results as regards friction; assuming the latter to be 9.25 lbs., the tension was about equal to 47.6 + 9.25 = 56.85 lbs. The cost of every main pile driven was about 6*s.* 6*d.*, and of every intermediate pile 2*s.* 3*d.*, or equivalent to about 11.3*s.* per square yard of the wall. Had the pile-drivers been hand instead of steam-driven, the work would have been increased 13 or 14 per cent., and have lasted fully fifty-five days. This apparatus is specially valuable on extensive works, when the frequent removal of the engine is not necessary.

Researches on Ebullition.

BY M. DESIRE GERNEZ.

(Annales de Chimie et de Physique, March 1875, pp. 335—401. From Minutes of Proceedings of the Inst. of Civil Engineers.)

After having first reviewed the history of researches on ebullition, the Author proceeds to describe his own experiments, in the cases of liquids heated in contact with solids, and of liquids heated in contact with other liquids, whence he deduces the theory of ebullition, and considers lastly the action of mechanical force on the phenomenon.

LIQUIDS HEATED IN CONTACT WITH SOLIDS.—When heating a liquid above the normal point of ebullition, ebullition is accompanied with explosion. In his experiments the Author used cylindrical glass vessels, washed perfectly clean with sulphuric acid, and closed at one end.

The liquid he employed was pure and free from solid matter: it should be poured into the tube so as not to imprison any air, and ought to be heated in water or paraffin baths, as, in consequence of the bad conducting qualities of glass, a naked flame might heat a portion of the fluid to a higher temperature than it can endure. He was careful not to produce vibrations. The following conclusions were arrived at:

1. Solid bodies which cause boiling of superheated liquids lose that property when highly heated. When certain portions of platinum wire, heated either in closed glass tubes or by means of an electric current, are immersed in a liquid, the heated portions remain inactive.

2. Solid bodies without chemical action on superheated liquids cease to produce bubbles of vapor having caused boiling for a longer or shorter period. If a piece of stearine be inclosed in a bell-shaped glass or vessel, attached to a glass tube, shut at its upper end, and introduced into water heated to boiling, bubbles will not rise atter the first few minutes, even if there be air above the stearine. Let a piece of spongy platinum be made white hot, and put into boiling water for five minutes; let boiling be suspended for five minutes, and let this action be repeated. After a time water above 212° Fahr. will not produce a single bubble with the platinum.

3. A body, the surface of which has not been in contact with air, or which does not contain air or gas, has no effect on superheated liquids, Introduce a glass tear into a thick glass vessel, the water in which is kept boiling until no bubbles come from the tear. Let the water cool and break the point of the tear. The result is an explosion which reduces the tear to powddr; but though the water be again superheated, the glass fragments will not cause boiling.

4. Solid bodies rendered inactive, by remaining in a boiling liquid, or through the influence of heat, become active again on exposure to the air. If a platinum wire which has been rendered inactive by its presence in boiling water be carefully removed, so as not to be exposed to dust, and again replaced in the liquid, it will reproduce boiling.

5. A gaseous atmosphere causes the boiling of superheated liquids. Introduce into a superheated liquid a small bubble of air by means of a tube with a bell-shaped mouth closed at its upper extremity, and the liquid will immediately boil. When the mouth of the bell is covered with wire gauze, bubbles are formed where the pressure is least; and it is found that the effect of a single bubble of air is continuous.

EXPLANATION OF THE PHENOMENON OF EBULLITION.—Place a liquid in a perfectly clean tube, raise the temperature at the surface of the liquid: vapor will be produced with a maximum tension corresponding to the temperature, or an inferior one, as the space is limited or unlimited: by raising the temperature the tension will become equal to the atmospheric pressure, when boiling will be possible, if there is a gaseous bubble in the liquid. Next the volume v being the volume under the atmospheric pressure P, the new volumes will be unlimited when the maximum tension of the vapor is equal to P, being then $\frac{v\,P.}{P-P}$. On the other hand, ebullition can be retarded to the temperature of the total evaporation of the liquid, or to a temperature approaching that at which, in the experiment of Cagniard de Latour, the liquid becomes expanded to vapor.

The Author then discusses the mechanism of ebullition and shows that—

1. Ebullition is an evaporation at the surface of rhe introduced gases.

2. An infinitely small quantity of gas suffices to produce unlimited boiling.

3. Each bubble of vapor is formed at the expense of a certain quantity of air.

4. A bubble of vapor on quitting the orifice of a tube leaves a very small bubble behind which coutinues to sustain ebullition.

5. Bodies which are not wetted by liquids produce ebullition, because the liquid is kept at a distance, and the dissolved air will gather in the spaces.

6. A dimunition of pressure will allow the liquid to be superheated, because the dimunition takes place slowly, and the dissolved gas is disengaged at the free surface of the liquid, thus allowing an elevation of temperature without the production of gaseous bubbles.

LIQUIDS COMPLETELY SURROUNDDED BY OTHER LIQUIDS.—A drop of water introduced into a mixture of essense of cloves and linseed oil can be slowly superheated, and if free of gas will remain liquid up to the temperature of total evaporation. If it contain air, the elevation of temperature will produce a supersaturated solution, and will retain the disolved air up to this limit; but in the assumed case the dissolved gas will diffuse into the surrounding liquid. Thus by slow heating the water will attain higher and higher temperatures without boiling.

EBULLITION PRODUCED BY MECHANICAL ACTION.—If a rod be rubbed briskly along the surface of a vessel containing a superheated liquid, boiling will at once be produced, the action producing bubbles of gas, which were in the state of a supersaturated solution.

The Author gives the following applications of the theory of boiling:

Normal boiling point.—It being very easy to superheat liquids, some difficulty has been found in obtaining the normal point of ebullition; this can be easily remedied by the introduction of a bubble of air, or the employment of porous substances not acting chemically on the liquid.

Starts.—If a porous substance has been employed to produce normal boiling as described, and if the liquid is cooled and again heated, it boils with starts, owing to the capillary channels having lost the greater portion of their air; the liquid contained in them can be superheated, until a bubble of air coming from the interior portion causes the sudden formation of a large quantity of vapor. This action can be avoided by the employment of substances which by their action on the liquids produce even small quantities of gas, such as spongy platinum, and zinc and iron for water.

Explosions of steam boilers by the sudden expansion of vapor in superheated liquid.—The fact that explosions frequently occur on renewing work, when the water has been maintained without external expenditure of vapor at a temperature little inferior to that of boiling, leads to the opinion that the cause lies in the sudden expansion of vapor in the superheated liquid. A piece of coke, or the introduction of a solid substance with the fresh water, which will produce a bubble of vapor in the superheated liquid, would cause an explosion. A piece of metal, such as zinc, maintained in the boiler would obviate such results. E. B.

NOTES.

The Boston & Providence Railroad is now receiving, from the Edgar Thompson Steel Combany of Pittsburg, Pa., steel rails sixty feet in length. This extraordinary leugth of rail is strongly illustrative of the growth of the railroad in America. The first rails laid upon the Providence Railroad in 1844 were 12 feet in length; then in a few years fifteen-foot rails were used, and the length has since been gradually increased by rolling to eighteen, twenty-one, twenty-four, twenty-eight and thirty-foot rails. The thirty-foot rail has been used for about four years, and now we have the sixty-foot rail. The Edgar Thompson Company has on exhibition at Philadelphia a rail 120 feet in length, which is labelled "The longest rail in the world."

The scheme for a canal between the Channel and the Mediterranean is being seriously taken up. The Commissioners, adopting the estimate of state engineers, put the cost at $13,000,000—namely, $2,000,000 outlay on the lower Seine, $1,000,000 on the upper Seine and Yonne, $2,000,000 on the Burgundy Canal, and $8,000,000 on the Rhone. It is intended to carry vessels of 250 to 300 tons.

The Late Ransom Gardner.

Ransom Gardner, for many years a prominent citizen of this state, died on the 9th, at Anderson, Ind. He had just substantially completed the construction of a new railway line from White Pigeon, in this state, to Anderson, Ind., which has occupied his attention for several years.

Mr. Gardner was born at St. Ann. N, Y., In 1814, but removed to Elbridge in the same state when a young man He came to Jonesville, in Michigan, in 1837, and was for some time a successful merchant in that place. While there he filled his first contract in railroad building, which was the grading of a section of the Michigan Southern Railway. This was followed by another contract on the same road, and then on the Chicago & Rock Islandline, and during the latter undertaking he purchased a tract of land of 1,600 acres, west of Chicago, and platted a large village.

Mr. Gardner ultimately removed to this city, and under his supervision ihe Detroit & Toledo Railway was built; next he constructed the Jackson & Adrian branch, reaping large profits from these various enterprises. His business ventures here were numerous, and he became interested in mercantile enterprises, in vessel stock, and in various railroad investments. About 1864 he took charge of the reconstruction of the railroad from White Pigeon to Three Rivers and its extension to Kalamazoo, and removed to Three Rivers and thence to Kalamazoo. Still later he built the Grand Rapids, Allegan & Kalamazoo Railroad (with its Holland branch,) which was ultimately sold to and consolidated the Lake Shore line. Next he engaged in the enterprise of building the road from White Pigeon to Anderson, Ind. which he had just completed, having pushed on its construction during the business depression of the last throe years, when other railroad enterprises were utterly at a stand still.—*Detroit Tribune.*

New Publications.

Notwithstanding the existing depression in the iron trade, and the fact that the trade is represented by some of the most excellent journals in the country, there is to be found a publisher so enterprising as to send forth a new claimant for favors in that direction. The *Iron Trade*, published at No. 132, 134 and 136 Nassau St., New York City, by Lawrence G. Grulding, is the latest candidate; and its appearance and "make up" thus far is very creditable indeed. It is an eight page paper of the usual unwieldy size ot iron trade papers, and besides being well supplied with "iron" articles, gives four pages of market reports. It is edited by J. D. Nolan, Mechanical Engineer, and its subscription price is Three Dolllars per a nnum in advance.

We chronicle the birth of a new candidate for public favor in "*The Railway Age*," published every Saturday by the Railwry Age Publishing Company, Grand Pacific Hotel, Chicago. Price, $4.20 per anuum. It is neatly gotten up and the editorial mattei is spicy and well written.

It would seem as if in the present state of the railroad interests an additional paper of that class was hardly needed, but the proprietors seem to think the contrary, as appears from the following editorial extract:

"The railway interest of the country and the world is just now at its lowest ebb. It is about to meet the return tide and roll forward to prosperity as yet unknown. *The Railway Age* proposes to take it at its flood, and with it flow on to fortune. In this faith appears the publicrtion whose innitial number is now before you.

PROPOSALS FOR CONTRACTS.

BRIDGE WORK.—Bids will be received at the office of the Commissioners of Hamilton Co., O., in Cincinnati, until Saturday, July 1st at 12 M., for masonry, excavation and superstructure for a bridge across Symmes Creek, on the road from Symmes to the Sixteen-mile Stand, Symmes township. Specifications can be seen at this office. Jos. B. Humphreys, Auditor,

BRIDGE WORK—Proposals will be received at the office of the County Commissioners of Hamilton Co., O., in Cincinnati, until 12 M., July 1st for making the approaches to three bridges in Sycamore Township: 1st, Over the Miami Canal, on the road from Glenwoad to South Glendale; 2d, Over the Miami Canal, on the road from Glendale to Sharon; 3d, Over the West Branch of the East Fork of Millcreek, on the road from Glendale to Sharon. Specifications can be seen at this office. Jos. B. Humphreys, Auditor.

BRIDGE—Proposals will be received by the Commissioners of Portage Co., Ohio, at their office in Ravenna, Ohio, up to 12 M July 1st, for the construction of a triple arch stone bridge over the Cuyahoga river on Main St., in the village of Kent, in Portage Co. Proposals will be for the entire masonry complete, in accordance with plans and specifications; proposals by the perch will not be considered. Plans and specifications for the above work will be on file in the County Auditor's office. Two piers and one abutment in this job is to be built to Spring Line, under the present bridge now standing, on or before November 1st 1876 and the entire work to be completed on or before September 1st 1877. Wm. Grinnell, Co. Auditor.

BRIDGE—Proposals will be received at the Auditor's office, Batavia, Ohio, until 12 M, June 28th, for the superstructure of the following bridges: Two spans 120 ft. each across East Fork Little Miami, near East Liberty; One span 165 ft. across same stream near Batavia; One span 130 ft. across Stone Lick, near the Catholic Church. Bidders will furnish their own plans and specifications. C. J. Harrison, Auditor.

BRIDGE—Bids will be received at the office of the Commissioners of Hamilton Co., O., in Cincinnati, until July 1st at 12 M. for masonry of the abutments of a bridge across Millcreek, on the road from Hartwell to Lockland, in Sycamore township. Specifications can be seen at this office. Also, for an iron superstructure at the same place, clear span 80 ft.; clear roadway, 18 ft. Bidders will furnish their own plans and specifications therefor. A full and complete strain sheet to accompany each plan. Said bridge must be of sufficient strength to sustain 100 pounds per square foot of floor surface beside its own weight; factor of safety 4 15,000 tension, 12,500 compression. Payments will be made in Hamilton Co. bonds, bearing interest at 7 per cent, By order of Commissioners. Joseph B Humphreys, Auditor.

BRIDGES.—Proposals will be received by the Commissioners of Clark County, Ohio, for the building of Bridges at the places, and of the lengths, named below: One at Hoffman and Yeazell's fording of Sinking Creek, in Moorefield Township,—length of span, 50 feet. One at Newlove's fording of Beaver Creek, in Harmony Township,—length of span 60 feet. One at Dibert's fording of Chapman's Creek, in German Township,—length of span 80 feet. One at Medway fording of Spring Creek in Bethel Township,—length of span 80 feet. One at Miller's Creek in German Township,—length of span 120 feet. Bidders may furnish plans and specifications for the whole work on each bridge, for either stone or wood in abutments, or both, including excavation and all under-plank necessary to secure a good foundation; and for such plan of superstructure as they may propose to erect. Bids for the stone-work to be by the perch of 25 cubic feet; bids for wooden abutments by the foot, lumber measure. Bids will be opened on the first Monday in July, 1876, being the third day of said month, at the rooms of the Board in Springfield. Quincy A. Petts, Auditor of Clark County, Ohio.

CHURCH,—Proposals will be received by the Building Committee of the M. E. Church, at McKeesport, Pa., until July 1, 1876, for the esection of a new church building. Plans and specifications can be seen at the office of Dr. W. Knox, McKeesport. James O'Neil, Joseph A. Stone, S. S. Crump, T. H. Courson, Dr. W. T. Knox, Huston Todd, John McCleany. Building Committe.

COAL GAS.—The City of Dubuque, Iowa, will receive bids for furnishing the best quality of Coal Gas for the use of the City. Acceptable security required. The City reserves the right to reject any and all bids. No bids received after August 1st, 1876. The furnishing to commence on the 14th day of September, 1877. For further partieulars inquire of C. G. Hargus, City Recorder.

COUNTY POOR HOUSE.—Proposals for the building of a County Poor House will be received until 1 o'clock P. M., Thursday, June 29, 1876, at the office of the County Auditor, in Butler Center, Iowa. The building must be built according to plans and specifications on file in the Auditor's office. Bids must include the entire cost of the building. Stone work, carpenter and joiner work, painting and plastering. R. L. Chase, Auditor.

COUNTY PRISON EXTENSION—Proposals will be received by the Commissioners of Schuykill County, at their office, in the county court house, Pottsville, Pa., until 4 P. M., June 28th, for the roofing, plumbing and gas fitting, plastering, painting and glazing required for the extension of the Schuykill County Prison. Each of said proposals to be indorsed separately as above enumerated. Plans and specifications of the work may be seen at the Commissioners' office until June 24th. Morgan W. Fehr, Louis Blass, Patrick Collins, Commissioners. E. A. Schartel, Clerk.

CHURCH—Proposals will be received by the undersigned for furnishing the materials and erecting the Swedish Evangelical Luthern Church of Moline, Ill. Dimensions, 116x62 feet, exclusive of buttresses. Basement story 12 ft., principal story 28 ft. aisles and 46 ft. nave; built of brick and trimmed with stone. The plans and specifications can be seen at the studio of Rev. A. G. Setterdahl, Moline, Ill. until 12 M. June 26th; after that at the office of I. N. Holmes. architect, Room 23, Mitchell & Lynde's block, Rock Island, until 12 M. July 12th. Bids will be received for the whole job complete, or for the brick and stone work and carpenter work, separately; the carpenter to bid with and without the spire above brickwork. A. G. Setterdahl, Chairman of Building Committee.

GRADING.—Proposals for grading on the Butler Center and Parkersburg road will be received until 1 o'clock P, M., June 29, 1876, at the office of the County Auditor in Butler Center, Ia. The location of the work, the style and extent of the same can be ascertained by inquiring at the office of the County Auditor. The bids must be for grading at a certain amount per cubic yard. R. L. Chase, Auditor.

LAYING GAS PIPE—Proposals will be received at the Wheeling, (W. V.) city gas office until July 3d, for laying an 8 inch gas pipe, with drip boxes and pump, across the Ohio river opposite 21st Street, in said city. All bidders to furnish their own specifications and name the price at which they will do to the satisfaction of the Superintendent of Gas Works and the Trustees. J. L. Maxwell, Secretary.

NATIONAL MILITARY CEMERERIES.—Proposals, in triplicate, with a copy of this advertisement attached to each, will be received at the office of the National Cemeteries, at Washington, D. C., until Saturday, July 15, 1876, for the construction of a Superintendent's Lodge, of brick or stone, at the National Cemetery at Grafton, West Virginia. Also for the construction of an enclosing wall and a Superintendent's Lodge, of brick or stone, at the National Cemetery at Finn's Point, N. J., —opposite Fort Deleware. The work during its progress will be frequently inspected by competent engineers, and a strict compliance with the terms of the contract will be required. Copies of plans and specifications may be seen at this office and at the Quartermaster's office at Philadelphia, Pa., 1129 Girard Str., also at the Bemeteries above mentioned. A. F. Rockwell, Captain and A. Q. M.

PUBLIC HALL.—Plans, specifications and estimates for erecting the first of two stories of the Washington Hall, in Wheeling, West Va., including the trusses and joist for the support of the third floor, together with the roof covering the same, will be received by the undersigned up to 10 o'clock A. M., June 30th, 1876. Two sets of plans will be required, one for offices on the second floor, and one as an assembly room, the cost of the building after either plan not to exceed $15,000. Plans are also invited for the building of a third story over the two stories above referred to, suitable for Masonic purposes, the cost of said third story not to exceed $10,000. By order of the Directors: I. H. Williams, Secretary Washington Hall Association.

ROOFING SLATE—Proposals will be received at the office of the Kansas State Penitentiary in Leavenworth, Kansas, and opened at 2 P. M., July 6th, for about 75 squares of roofing slate, punched for nails, and sufficient nails to put the same on, and delivered on the cars at Penitentiary Switch. It is not necessary to be even in color, but of good quality for shop roots. Henry Hopkins, Warden.

SCHOOL HOUSE.—I will receive sealed bids until 2 o'clock, Saturday, July 8, for the building of either a frame or brick School House in Sub-District No. 6, Boomer Township, Iowa. Specifications at George Bebbington's or L. S. Axtell's. George Drake, Sub-Director of No. 6.

SCHOOL HOUSD.—The undersigned will receive bids up to July 1st, 1876, for furnishing materials for, and building a school house in Pekin, Ill. The plans and specifications can be seen at the office of Henry Lautz. The party obtaining contract will have to give a bond for twice the amount of the cost of school house, for the faithful performance of said contract. For particulars see the undersigned. Peter Steinmetz, Chairman of Building Committee.

SCHOOL HOUSE—Bids will be received by the School Board of Washburn, Ill., until July 1st, at 12 M. for the erection of a brick school house in accordance with the plans and specifications on file in the office of W. J. Edbrooks, 179 E. Madison, St., Chicago; each bid must be accompanied by a bond of the usual form, in the penal sum of $200. Address proposals to S. W. McCulloch, Wrshburn, Ill., indorsed "Proposals for Building a School Building." S. W. McCulloch, Secretary.

STREET IMPROVEMENTS—Proposals will be received at the office of the Board of Public Works of Cincinnati, O., until 12 M. July 10th for grading. curbing. flagging gutters, macadamizing the road bed and constructing the necessary culverts. drains or retaining walls, in accordance with specifications on file in the office of the Board of Public Works, Locust Street from Mount Street to Mason Street. John E. Bell, President.

ST. ANTHONY'S FALLS IMPROVEMENT—Bids in duplicate will be received by the undersigned, at the U. S. Engineer's office, in St. Paul, Minn., until 12 o'clock, noon, June 29, 1876, for the following work at the Falls of St. Anthony, Minneapolis, Minn. 1. Furnishing the materials and constructing two dams on limestone ledge. 2. Filling a portion of the old tunnel and other passages under the lime rock above the dyke. For all information apply to F. U. Farquhar, Major of Engineers.

STEAM HEATING APPARATUS—Proposals will be received until July 10th at 12 M., for a steam heating apparatfor the Buffalo State Insane Asylum. Proposals may be in accordance with two plans and specifications, or either of them, marked No. 1 and 2 respectively, now in the posession of the Board of Managers; or any party may submit other plans and specifications with their proposals. Proposals will be received for the entire work complete, or for the boilers, engines, fans, piping, radiators, or for any portion of the work herein enumerated separately. Plans and specifications can be seen and further information obtained at the office No. 31 City and County Hall. Proposals will be addressed to Wm. F. Rogers, Secretary, No. 31 City and County Hall, Buffalo, N. Y. James P. White, President Board of Managers.

STATE ROAD—In pursuance of Act 177 of 1859, and Acts amendatory and supplementary thereto, the undersigned, Commissioner of the Presque Isle & Little Traverse State Road will receive proposals in writing for the construction of that portion of said road as follows: Commencing at the point near Little Traverse Bay, at the intersection of the east line of the northwest quarter of northwest quarter of section 6, town 34 north, of range 5 west, with state road, and running thence easterly on surveyed line of said road to the southeast corner of section 6, town 34 north, of range 3 east, being a distance of 45 miles and 35 chains. Contracts will only be made with responsible parties who will be required to furnish two acceptable sureties as a satisfactory guarantee that the parties proposing will enter into contract as required, and complete the work in good, workmanlike manner by Dec. 1st, 1877. Proposals will be received at my office in the village of Petoskey City, Mich., until 4 P. M., July 10th, at which place the survey of said road and form of contract required may be seen, and such other information obtained as may be desired. Payments for the work will be made by the state in any vacant state swamp lands in the Lower Peninusula at the minimum price established by law. John Keep, Local Commissioner.

TOWN HALL.—Proposals will be received at the office of the Village Clerk, at Toulon, Ills., until 6 o'clock P. M., July 12th, 1876, for building and finishing a Town Hall, 40 by 83 feet in size. Plan and specifications can be seen at the office of said Clerk, J. D. Rhodes, Prest.; J. M. Lowman, Clerk.

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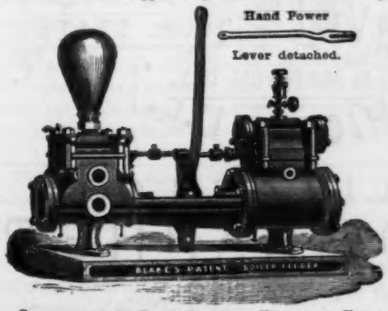

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Extract from report of Committee of Civ. Engs. appointed by Franklin Inst. to examine H. & B.'s new Transit [Dec. 1871]: "It exhibits several novelties of construction which, in the opinion of the committee, render it superior to those now in use, and in its opinion the deviations which they have made from the common styles of Transit are decided improvements."
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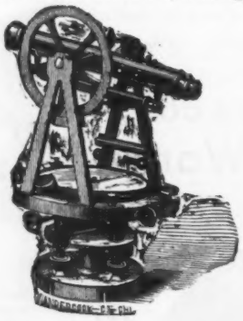

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CONTENTS:

Editorial Notes	209
The Detroit Tunnel	209
A Public Nuisance	210
The Fort Wayne, Ind., Water Works	210
Proposed Water Works at Marion, Ind.	210
Seventh Annual Meeting of the Civil Engineers' Club of the Northwest	210
Annual Meeting of the American Insti. of Mining Engineers	211
Judges at the Centennial	211
Railroad News	211
The Fullerton Avenue Conduit, I (with Maps and Profile)	212
Contractors' Intelligence	214
Notes	214
Submarine Telegraphy	214
Contractors' Plant	215
Canal Lock Lift	216

ENCOURAGED by the cordial support which we have received on every hand, we have this week enlarged our paper to a twelve page sheet. We shall spare no pains to keep abreast the spirit of the times in every particular, and make ENGINEERING NEWS the true exponent of engineering progress in this country.

GEN. G. K. WARREN, of the Engineer Corps, in a paper submitted to the War Department in 1875, advances some very interesting theories in regard to a motion of the continent about an axis extending from S. E. to N. W. On the northeast of this axis the land is settling. He adduces the fact that Greenland has been sinking ever since its occupation by the Danes, and agin, the deep estuaries of the St. Lawrence and coast of Laborador; also many rivers which have changed their course. On the southwest and in the Rocky Mountain region the land is rising.

In a period following the glacial epoch the Gulf of Mexico extended up to Cairo; the Ohio as far as Louisville, the Missouri to Omaha, and the Mississippi to Rock Island where all estuaries of the sea. The Mississippi at that time drained via. the Minnesota River, a great lake covering all the valley of the Red River of the North and a large territory about Winnipeg Lake.

There are many evidences of the existence of such a lake and also, the slope and valley of the Minnesota point to a time when a much larger volume of water flowed through it. The whole of the great lakes except Ontario drained southward by the Illinois.

As the continental motion went on these outlets of two great lake systems eroded their valleys deeper to keep corresponding pace.

For a hundred miles near the divide, the Minnesota River flows through a granit bed through which the erosion could not keep pace with the continental dipping, and hence, the outlet was in time cut off, the lake pouring over the mountain range to the north and cutting the deep gorge of Nelson River into Hudsons Bay. In the case of the Illinois the presence of a hard dolomite bed at Lockport, effected the same object and in course of time the lakes poured over the edge of the basin at Buffalo.

THE theory of Gen. Warren is very interesting and is well supported by the facts.

It is curious to think that a strata of magnesian limestone of less than 30 miles width should have prevented the erosion of the Illinois valley up into Lake Michigan. In such event Lake Michigan would have been much contracted in size and its surface 140 ft. below present level A rapid the same as at the Sault St. Marie would have existed at Mackinaw. Lake Huron would have been 50 ft. below present level, and Lake Erie wonld have discharged its waters into Lake Huron by a river everyway similar to the present outlet of Lake Superior.

THE FALL of the Illinois River from Peru to its mouth, a distance of 222 miles is 19.5 ft. or an average of less than 1¾ inches per mile. The river itself is a succession of pools and bars, nearly the total fall occurring on the bars. All the configurations of the valley and almost abnormal slope of the river point to an ancient river of far larger volume.

This river is now being improved on the slack water system. Five dams will be required from Peru to the mouth, to secure 7 ft. navigation. The locks will be built 350 ft. long and 75 ft. wide, allowing of the passage of boats of 300 ft. length and 72 ft. width. One dam at Henry is now completed, securing the desired navigation for a distance of 25 miles. A second at Copperas Creek will be completed during the present season. This dam will give 60 miles additional slack water. When the five dams are completed no doubt the Illinois Canal will be enlarged to corresponding dimenisons. The length of the Illinois and Michigan Canal is 96 miles. Of this three miles is the Chicago River which will need no enlargement; 33 miles from Bridgeport to below Lockport will need enlargement as a canal; the remaining 60 miles of canal will probably be abandoned as the upper river can be improved on the same system as the lower river. The total lockage is 145 ft. When this improvement is complete throughout its entire extent the largest class of Mississippi boats can make the harbor of Chicago.

As suggested by this, we understand that some ambitious persons have formed a company for a steamship line between St. Louis and Brazil. The Mississippi River is deep enough for the largest ocean vessels as far as Memphis. From that point to St. Louis there are occasional bars or shoals that would not allow of the passage of ocean vessels. How the difficulty is to be overcome we do not know, but we presume by a system of dykes, confining the current as at the South Pass. Of course the realization of such a scheme depends on the success of the jetties at the South Pass which now seems probable.

Capt. Eads has foreshadowed such an improvement of the river in some of his written articles and no doubt will be ready to attack all who disagree with him in a short time.

CAPT. EADS has also another idea which he is prepared to defend. In his review of the Report of the Levee Commission, he advocated the use of cut-offs to permanently lower the flood line of the river, so as to do away with levees entirely. No doubt if such a scheme is practicable, it would be a great saving of money as the expense of the levees as recommended by the commission is some $40,000,000. Whether such a scheme is practicable or not we cannot say. The effects of cut-offs on the regimen of the river is by no means certain, and might develope results beyond engineering control.

Lieut. Abbott's reply to Capt. Eads Review vitiated many of the facts on which Capt. Eads based his conclusions.

A NEW machine for compression of air, invented by MM. Dubois and Francois, and which is used in the coal mines of Wenster, near Luttich, for working boring machines, is described in *Dingler's Polytechnishes Journal*. The air-compressing piston and the steam piston are in one piece, but the essential part of the mechanism is the mode of cooling the compressed air, which is by means of two injection roses introduced into the two cylinder covers and connected by pipes with the under side of the compression reservoir, which is filled partly with water, partly with compressed air (the latter thence conveyed to the boring machine). A fine continuous spray is thus ejected on both sides of the piston. When the latter is at one end of its course it presses a portion of the water, which now fills the whole cylinder space on one side of the piston, back into the compression reservoir. Further, water is of course carried off with the compressed air and is thrown down into the compression reservoir and cooled, so that the same water is in continuous circulation, is alternately heated in the cylinder and cooled in the reservoir. With this engine fifty revolutions can be produced in a minute, giving an effect nearly three-fold that of the ordinary air compressors.

THEY are building in New Orleans an establishment for manufacturing ice. It is 115 by 150 feet, and has walls 50 feet high and 3½ feet thick. These walls are triple, with sawdust and air spaces. The interior contains over 5000 three-inch iron tubes, 36 feet high, placed upright in pairs, five feet apart, and each pair connected at top and bottom. Vaporized ammonia, forced through these tubes by steam power, brings them to a point below zero, and water dashed upon them in spray freezes, and forms a coating of ice upon the tubes, which gradually thickens until columns are formed 36 feet long and 2½ feet thick. These are then sawed up and down and riven off rapidly from the tubes. One-half of the tubes will be used this season, capable of making eighty tons of ice daily.

A HARTFORD man has invented a simple but ingenious arrangement for effectually preventing the opening of a lock during any given length of time. It has an hour-glass contrivance fitted on a pivot on the inside of the door, connecting with the lock so that the lock bolt cannot be pushed back except when the glass is perpendicular. The lock is set by turning up the full bulb of the glass, resting it against a little elbow where the weight of the sand or fluid holds it in position until enough of the contents have run into the lower bulb to change the centre of gravity, when the glass will swing perpendicular, moving at the same time the cam and leaving the bolt free. The flow of the sand or fluid can be regulated and timed with exactness.

THE DETROIT TUNNEL.

It is often hard to the uninitiated to discover the motives which so often determine the failure or success of some engineering work which, in an engineering point of view, is entirely feasible. Such is the case of the Detroit Tunnel; a scheme which was well under way some three years since, the trial shafts and headings of the drainage tunnels having been pushed far enough to determine its practicability. The difficulties, it is true, were greater than was anticipated, but not of such a character as to warrant its abandonment; yet the railway companies saw fit to give out that great difficulties had been met with and that the expense of its completion would involve its failure in a financial point of view.

Probably the truth is that the railway companies would very much like to place all possible obstruction to lake commerce in the Detroit River, and accordingly, ever since, they have advocated a low bridge with two draws. Anyone acquainted with the nature and extent of the commerce that passes Detroit knows how such a bridge would affect it.

A bridge built under the restrictions imposed by the Government Engineers would be an enormous and unwarranted expense, and so if one is ever built the railways must rely on such influence, of an uncertain character, as they can bring to bear on legislative enactment.

We understand the people of Detroit do not favor a bridge on account of their large marine interests, much preferring a tunnel.

At the present writing Gen. Wm. Sooy Smith is negotiating with a committee of the Common Council of Detroit in regard to a tunnel. The following extract from his letter to the Council a short time since will explain his proposition, which, it will be seen, is very favorable to the city.

"If the committee of the Common Council appointed to look into my plan and proposal for building a tunnel so desire, I will visit Detroit and confer with them on the subject. My plan has never been explained to any one, and I will make the proposal in such shape as to make such explanation unnecessary except as to the final result, which shall be a tunnel under the Detroit River at any point that may be fonnd best at or near the city of Detroit, which shall be of sufficient capacity and unquestionable strength and durability. A reasonable price (to be agreed upon in the beginning) to be paid me only when the work is completed and ready for use. I will furnish bonds in the full amount of the price fixed for the faithful performance of the work, and I don't think the cost of the tunnel will much exceed that of a first-class double-track bridge. I am willing to submit my plans confidentially to a board consisting of say five of the ablest engineers in the United States, such board to be nominated by the American Society of Civil Engineers."

Gen. Smith's reputation as an engineer augurs the success of the scheme, and should it fail the city loses nothing.

The railway companies have thus far exhibited little interest in his proposition, and it will be instructive to note their tactics should it be approved.

A PUBLIC NUISANCE.

In 1871 the *deep cut* on the Illinois and Michigan Canal was completed at an expense of some $3,000,000. This drew from 25,000 to 30,000 cu. ft. of water per minute from the lake through the South Branch, cleansing it effectually.

During the year following Chicago had a lower death rate than for many years previously and certainly lower than ever since.

In 1872 some land speculators completed the Ogden Wentworth Ditch which, commencing at the Des Plains River near Riverside, extending through the old Mud Lake region, a distance of five miles to the West Branch of the Chicago River, joins the Canal and South Branch at Bridgeport. This ditch drains several hundred acres of land in the towns of Cicero and Riverside, and the sink known as the Mud Lakes, lying between the Canal and the Des Plaines River, extending from near Summit about three miles to near the West Branch.

In medium high water this ditch has a fall of 9 ft. and turns into the canal and river from 15,000 to 25,000 cu. ft. of water per minute for about eight months in the year.

Two results follow: Frst, this amount of water discharging into the Chicago River at the head of the canal simply flows down the canal thus entirely negativing the current in the river, destroying the expected benefit from the through cut. Second: Immense quantities of alluvial soil is carried into the canal and river. This is not deposited to a great extent in the normal prism of the canal owing to the current, but wherever a widening occurs and in the basin at Lockport and above Dam No. 1, at Joliet, serious deposits have taken place, in some instances preventing the use of the docks. In the South Branch this deposit may average 2 ft. and in some places, as in eddies, soundings have shown as much as 7 ft. Of coure in the case of the S. Branch a portion of this may be due to sewage.

The Canal Commissioners estimate the cost of removal of the deposit in the canal at $25,000 and the injury to the S. Branch at nearly half a million dollars.

It seems a sad comment on the Board of Public Works of Chicago that they should allow the benefits of the canal improvement for cleansing the South Branch, to be largely vitiated by an influx of water from the Des Plaines River, which at times entirely negatives the current from the Lake and at the same time threatens to fill up the river and canal with deposits.

We understand that measures are being taken to cut off the ditch at the Des Plains River by a dam. These negotiations have been going on now for some two years and we cannot learn that the prospect of a dam is any nearer realization. This nuisance should be stopped immediately and the city given the benefit of an improvment she has spent so much to secure.

The Fort Wayne, Ind., Water Works.

We are pleased to announce that the question of water works at Fort Wayne, Ind., which has excited so much discussion, and which the City Council has been considering for nearly a year has at last been definitely settled, and that this enterprising city will not much longer be without this needed improvement. At a special meeting of the council held on the evening of the 22d ult. a majority report of the Committee on Water Works, to whom the proposition of the owners of the canal, from which the water supply is to be derived, to build the entire works was referred, was made in favor thereof and accepted by a vote of 10 to 9, Mayor Zollinger casting the deciding vote,

The following is the proposition of the owners of the canal:

To the Committee on Water Works:

GENTLEMEN: We will convey and fully warrant to the city of Fort Wayne, all, or such part of the canal, as she may want for water works purposes—reserving to ourselves all surplus water;

And we will furnish and lay in accordance with the plans and specifications of Mr. Lane, 4,800 feet of twenty-four inch pipe, 3,230 feet of twenty inch pipe, 1,870 feet of 12 inch pipe, 21,700 feet of eight inch pipe, 75,780 feet of six inch pipe, 5,460 feet of four inch pipe,—in all 21.18 miles of pipe.

We will also furnish and erect 178 fire hydrants, with the necessary connections, including such special castings, stop-cocks, and check valves as are required by said plans and specifications.

We will also furnish the material and erect on land not more than 200 feet from said canal feeder, to be furnished by said city for that purpose, the stand-pipe, filtering basin, engine houses, boiler houses and coal shed required by said plans, and we will furnish and erect in the proper places as shown on said plans suitable, and the necessary water wheels and the machinery to pump three million gallons daily, by water power, and a like quantity by steam power, to do which we will furnish one high pressure engine with the necessary boilers and fixtures.

For all of which we will receive in payments $365,000 of the bonds of said city authorized to be issued for the construction of water works, or cash; or we will in addition to the foregoing, furnish the necessary land on which to erect engine houses, stand-pipe, filtering beds, etc., and construct a tail race of sufficient capacity, and under the direction of the City Civil Engineer; and also properly clean the feeder from the place where said water works may be located north to the feeder dam, for the sum of $15,000 in cash or bonds.

Respectfully,

J. H. BASS,
O. A. SIMONS,
WM. FLEMING,
JAMES LILLIE.

Proposed Water Works at Marion, Ind.

Marion, Ind., has been for some time agitated over the subject of water works, and the Board of Town Trustees will, we are informed upon perfectly reliable authority, without doubt, at their meeting next week, pass an ordinance providing for their immediate construction. The plan at present contemplated for the new works is the direct pressure system, the water supply to be obtained from a well twenty feet in diameter with eighteen feet depth of water. There will be about five miles of pipe necessary, and forty hydrants. The works, the entire cost of which as contemplated, is from $30,000 to $35,000, will be let to the lowest bidder, after advertising for proposals.

Seventh Annual Meeting of the Civil Engineers' Club of the Northwest.

TUESDAY, June 27, 1:30 P. M.

A goodly company of engineers and invited guests boarded the special train at the Illinois Central Railroad depot, kindly placed at their disposal by that company, for the new Joseph H. Brown Iron and Steel Works at South Chicago, where the annual meeting was held.

The route was by the Illinois Central to the Belt Road Junction, then by that road and a Y of a mile in length to the iron works on the banks of the Calumet River about two and a half miles from Lake Michigan.

After passing the city limits the land on either side is a reedy marsh, very uninviting we should judge, as the site of the great city which all true Chicagoans expect to see at no distant day. The site of the iron works has been filled in some eight feet. On the Calumet 750 ft. of dock have already been constructed allowing access to the largest lake vessels.

On arrival at the works Mr. E. S. Chesbrough, President, and Mr. L. P. Morehouse, Secretary, utilizing a huge rotary sqeezer as a rostrum, called the members together for the election of officers etc. In the mean time the invited guests took an excursion on the Calumet.

The reading of the minutes of last meeting was dispensed with.

Col. Gillespie, Maj. of Engineers, in charge of Chicago Harbor Impovement, was elected to membership.

Mr. L. P. Morehouse, Secretary and Treasurer, read the report for the past year. We give that portion of it which is of more than local interest.

"The past year has, on the whole, been the most satisfactory of any in the history of the club. While far from having fulfilled all the hopes of its original members, the progress during the last twelve months of a deeper interest in its meetings and proceedings, has been very encouraging. Including the annual meeting of 1875 and the present one, ten meetings have been held since my last report. We have received fourteen new members and lost one by death. The latter, Mr. H. A. Gardner, was one of the most valued members of the club, and, in the course of his long and varied professional experience, had become widely known and highly esteemed by a multitude of friends who unite with us in mourning his loss.

Papers for discussion have been presented by the gentlemen named below:

Wm. Bryson. "The Goose Quill Business as applied to Waterworks Six Hundred Years Ago."

C. W. Irish. "The Attractive Influence of Running Streams upon the Magnetic Needle."

I. C. Chesbrough. "The Albany Waterworks."

F. W. Clarke. "Belt Railroad Projects about Chicago."

C. Latimer. "Waterwitching."

S. S. Greely. "The Riparian Question."

C. J. Quetil. "The One Rail Railroad."

W. S. Smith. "Method Adopted for putting in the Piers for the Bridge over the Missouri River at Boonville."

One meeting was devoted to a discussion of the merits of the Metric System of Weights and Measures.

An amendment to the constitution has been adopted, with reference to the proposition of new names for membership.

Donations of books, pictures, statistics, etc., have been received from Gen. A. A. Humphreys, Osgood & Co., Prof. R. H. Thurston, Chas. Latimer, Chas. Paine, Buff & Berger, Capt. W. H. Dall, Maj. J. A. Smith, W. W. Wilson and Chas. E. Fowler.

Mr. C. W. Irish has proposed to donate a collection of minerals and geological specimens as soon as the club shall provide a suitable place for it. Other members have also promised to contribute books and documents for a library.

Two hundred dollars have been appropriated toward defraying expenses of the Engineering Department at the Centennial.

On invitation of the proprietors of the Sherman House the club has held its monthly meetings at that place.

The hour of meeting has also been changed, at first to 4:30 P. M., and later in the season to 4 P. M., each time with an increased attendance.

The financial report was satisfrctory.

The balance on hand is $100.10.

The papers read at club meetings have been published in ENGINEERING NEWS, but no separate copies have been sent to members. Arrangements have been made, however, by which all the papers for the last year, including those of this meeting, will be bound in one volume, and a copy of this will be sent to each member.

Mr. Chesbrough being called upon for an address, stated, that more a lack of time than of material had prevented him from preparing a formal address. He had intended to discuss the three great routes to the east as described by Thomas Jefferson: First, by the lakes; second, by the Mississippi River, and third, by Lake Erie, the Ohio, Monongahala, and Potomac rivers.

It is curious that so great a man as Jefferson should have given his preference to the Potomac route, the only one at present not developed. But a new element, railroads, had been introduced into the problem which he did not contemplate.

He also referred to a century ago when it took four days to go from Boston to New York by wagon and seven days from Philadelphia to Pittsburgh on horseback and Louis and Clarke several months to cross to the Pacific coast, and contrasted them with the present time when the continent had been crossed in three and a half days.

All the old officers were reelected for the ensuing year, unanimously with the exception of their own votes.

The following are the officers elected:

For President, E. S. Chesbrough; Executive Committee, S. S. Greely and W. M. R. French; Secretary and Treasurer, L. P. Morehouse.

The president reminded the club that much of the success of the past year was due to the indefatigable secretary, Mr. Morehouse.

The following resolution was passed:

Resolved, that the secretary and executive committee be authorized and directed to give the thanks of the society to the proprietors of the Sherman House for the use of their rooms.

The meeting then adjourned to the regular time (1st Tuesday) in September, and the members proceeded to inspect the works under the direction of the manager, J. T. Torrence, formerly of the Joliet iron works.

All the plant erected or in prospect has been designed by Mr. Torrence and presents many new features of arrangement and detail.

The enterprise was inaugurated on the 5th of July 1875, with appropriate ceremonies. The mill for merchant iron is the only one completed and will be in

operation in about ten days. The main building is 400 feet long and 100 ft. wide with five wings of length ranging up to 215 ft. The plant consists of one 9" train, one 14" train, one 20" muck train, one 20" top and bottom mill, one 22" beam mill, a 136 ton squeezer, huggers, saws, shears, &c., all driven by separate condensing engines, supplied with steam from 16 tubular boiler 5 ft. diameter and 15 ft. long. 32 gas producers furnish gas for 12 puddling furnaces and 9 heating furnaces, the Martin Siemens process being used. All the fire grates are arranged for burning slack coal. Between every alternate bar, two short bars are mounted on axes by which they can be given a vibratory motion, thus destroying any clinker that may form. Hollow spaces are left in the wall between the grates, as it intended soon to use the waste gases from blast furnaces for heating the boilers, the draft being heated in these air spaces.

Steel works on the Martin Siemans process are to be erected soon; also Bessemer works and blast furnaces.

The plan of the Bessemer works which we examined consists of a succession of buildings combining blast furnaces, Bessemer plant, reheating plant, and rail mill, under one roof.

The blast furnaces are to discharge their products into huge ladders, which after weighing, are dumped into the converters, thence cast into ingots, reheated and rolled into rails. But very little transportation is required and this is rendered easy and economically by an admirable system of cranes and tracks. Gas is also to be used throughout these works for heating purposes. Spiegel will be manufactured at the works from Lake Superior or Missouri ores.

To carry out these projects as designed, involves the highest metallurgical skill as every iron master knows the difficulties to be overcome in puddling with gas and also in using the direct products of the blast furnace in the Bessemer process. The works are designed throughout with the idea of attaining the highest practical economy both in fuel and labor.

After spending the afternoon very profitably and pleasantly the party returned to the city where they arrived at 5:30 P. M.

Annual Meeting of the American Institute of Mining Engineers.

(Special Correspondence of Engineering News.)

PHILADELPHIA, Tuesday, June 20.

A meeting of the Mining Engineers was held this evening in the hall of the Franklin Institute. President Holley in the chair.

Mr. Gowan, President of the Philadelphia & Reading Railroad, and the Philadelphia & Reading Coal and Iron Co., delivered the address, welcoming the Institute to Philadelphia. He stated many very valuable facts in regard to a method of utilizing coal dust in combustion, which heretofore has been a great waste. The discovery was made under the encouragement of the speaker by a gentleman in the employ of the Reading Co. It was found that coal dirt without previous preparation, could be burned upon a grate made of a perforated plate. The draft is produced by a small jet of steam. Experiments have met with complete success in stationary boilers and also in locomotives so far as tried. Although the experiments with locomotives has not been so exhaustive as in the case of stationary engines, it is believed that complete and economical combustion will be accomplished. In some test experiments 8½ lbs. of water were evaporated per lb. of fuel.

It has been found necessary to introduce changes in the draft of the locomotive as the fuel is so light that it would all be carried up the smoke pipe by the exhaust.

Part of the exhaust is used to heat the feed water; the remainder on entering the smoke pipe passes up to the top and is obliged to descend before it finally escapes into the outer air. This arrangement assisted by the steam jet causes a very steady draft. The experiments on locomotives will continue. It is intended soon to commence experiments in Marine boilers.

When there exists in the coal regions literally mountains of this coal dust which has accumulated for decades and which hitherto has been considered of no value, 15 cents per ton being named for it in some cases, the value of any process which promises to utilize it can hardly be overestimated.

The address of welcome previously alluded to was then delivered. It spoke in generous phrase of the value of the Institute of Mining Engineers and was full of hearty tributes of welcome.

The President then announced the election of Hon. Abram S. Hewitt, as the president for the coming year.

The President elect favored the audience with a valuable address upon the History of the Developement of the Metallurgical Interests in this Country since its Discovery. The paper was very full and complete and no abstract of it would be satisfactory. It will soon be published.

At the close of this address the Institute and its guests adjourned to 2,100 Girard street, to partake of the collation given by the president elect.

To say that his contributions to the entertainment of the company at 1,100 Girard street were of the same complete, elegant and satisfactory nature as that given at the Fraklin Institute is only deserved praise.

WEDNESDAY, June 21.

The Institute and guests assembled according to programme at the Judges Hall on the centennial grounds about 10 A. M. The meeting was called to order by President Holley. Mr. Lothian Bell, read what was no doubt a very valuable paper upon the "Theory of the Hot Blast," but no one could hear it for the racket. The meeting was obliged to adjourn as no discussion was possible for two very good reasons. No one had heard the paper and no one could hear the remarks that might be offered in comment upon it. The adjournment was to the Franklin Institute, Friday, at 10 A. M.

To-morrow will be occupied by an excursion on the Delaware, substantially the same in character, though more extended than that made by the Civil Engineers. A *conversazione* will be held at 1100 Girard St. in the evening following the excursion. J. B. D

[As we are about to go to press further reports have been received from Philadelphia which we are obliged to defer until our next issue. ED.]

Judges at the Centennial.

In onr issue of June 17, we gave a partial list of the Judges at the Centennial. We give this week the details of organization and the duties of the judges.

1. Awards shall be based upon written reports attested by the signatures of their authors.

2. Two hundred and fifty judges have been appointed to make such reports, one-half of whom are foreigners and one-half citizens of the United States. They have been selected for their known qualifications and character, and are presumed to be experts in the groups to which they have been respectively assigned. The foreign members of this body have been appointed by the commission of each country, in conformity with the distribution and allotment to each adopted by the United States Centennial Commission. The judges from the United States have been appointed by the Centennial Commission.

3. Reports and rewards shall be based upon inherent and comparative merit. The elements of merit shall be held to include considerations relating to originality, invention, discovery, utility, quality, skill, workmanship, fitness for the purposes intended, adaptation to the public wants, economy, and cost.

4. To facilitate the examination by the judges of the articles exhibited they have been classified in groups, to each of which a competent number of judges (foreign and American) has been assigned by the United States Centennial Commission. Besides these, certain objects in the departments of agriculture and horticulture, which will form temporary exhibitions, have been arranged in special groups, and judges will be assigned to them hereafter.

5. The judges will meet for organization on May 24, at 12 A. M., at the Judges' Pavillion. They will enter upon the work of examination with as little delay as practicable, and will recommend awards without regard to the nationality of the exhibitor.

6. The judges assigned to each group will choose from among themselves a chairman and a secretary. They must keep regular minutes of their proceedings. Reports recommending awards shall be made and signed by a judge in each group, stating the grounds of the proposed award, and such reports shall be accepted, and the acceptance signed by a majority of the judges in such group.

7. The reports of the judges recommending awards based on the standards of merits referred to in Section 3 must be returned to the Chief of the Bureau of Awards not later than July 31, to be transmitted by him to the Centennial Commission.

8. Awards will be finally awarded by the United States Centennial Commission, in compliance with the Act of Congress of June 1, 1872, and will consist of a special report of the judges on the subject of the award, together with a diploma and a uniform bronze medal.

9. Upon matters not submitted for competitive trial, and upon such others as may be named by the commission, the judges will prepare reports showing the progress made during the past hundred years.

10. Vacancies in the corps of judges will be filled by the authority which made the original appointment. No exhibitor can be a judge. An exhibitor who is not the manufacturer or producer of the article exhibited shall not be entitled to an award.

11. The Chief of the Bureau of Awards will be the representative of the United States Centennial Commission in its relations to the judges. Upon request he will decide all questions which may arise during their proceedings in regard to the interpretation and application of the rules adopted by the commission relating to awards, subject to an appeal to the commission.

Railroad News.

Over 300 miles of railway have been built in Colorado during the past eight months.

There is at present, in the United States, one mile of railway for every 594 persons.

It is stated that subscriptions to the stock of the narrow guage railroad between New Bedford and Boston by the way of Middleboro, Mass., are coming in rapidly.

Surveys have been made for a railway in New Foundland. The proposed road is 380 miles in length, and estimated to cost $12,800,000.

The Deleware and Hudson Canal company, have commenced the manufacture of coal bricks, for steam fuel from coal dust. The bricks were recently tested on their road and found satisfactory.

It is reported from the Northern Pacific office that snow fences will be built this season along the Dakota division for the purpose of operating that part of the line next winter, which has heretofore been closed during the winter months.

The Delaware, Lackawanna and Western railroad company recently changed the guage on one track of their road between Scranton and Washington junction, a distance of seventy-eight miles, in seven hours and a half. At six o'clock in the morning a large force of men commenced at either end of the road, and at 1:30 the work was completed and narrow-guage cars sent over the route.—*Railway World.*

The Connecticut Valley Railroad Company, which has leased and run part of the Conneticut Central Railroad, and the Springfield and New London Railroad, since their completion, has given notice of the immediate termination of both leases, on the ground that it cannot afford to pay the rent demanded. Probably both roads will be run hereafter by the Connecticut Central.

The Canadian government is soliciting bids for the construction of the Pacific railway between Lake Superior and the Pacific ocean, contractors to receive lands or the proceeds of lands at the rate of 20,000 acres and cash at the rate of $10,000 per mile, together with interest at the rate of 4 per cent per annum for 25 years from the completion of the work, or any further sum which may be stipulated in the contract.

The surveying and locating party of the Little Rock, Mississippi River and Texas Railway has located the road from Little Rock to Pine Bluff, and as soon as the Fort Smith road is completed hands will be transferred and work begun. It is understood that about fifteen hundred hands will go to work soon, to a common center from Little Rock and the Bluff. It is understood the road has been located to Bowie Station, and that the surveying party will reach the Mississippi River in a few days. The line as now located, will place the road above overflow.

THE FULLERTON AVENUE CONDUIT.

A History of the Various Drainage Schemes of Chicago With Critical Notes on the Conduit at Fullerton Avenue.

By Lyman E. Cooley, C. E.

(Written for Engineering News.)

I.

Less than three thousand years ago, according to Dr. Andrews of Chicago, Lake Michigan poured its waters down the valleys of the Illinois and Mississippi Rivers to the Gulf of Mexico. An elevation of eight feet in the present level of the lake would again turn its waters into the old channel. Indeed, within the present limits of the city of Chicago the water runs into the Des Plaines River and thence by the Illinois and Mississippi into the Gulf.

The old outlet was down the "South Branch" of the Chicago River via. Bridgeport, the present Ogden and Wentworth Ditch, to the Des Plaines River at a point near Summit. A second, but more ancient outlet, was by the Calumet Lakes south of the village of Blue Island, following very nearly the old Calumet canal feeder to its junction with the Des Plaines near the village of Lemont. Between these two branches existed a large island, comprising about one-half of the townships of Palos and Lyons, the north part of Worth, and the southwest corner of Lake. Probably another rocky island covered the north portion of Hyde Park, notheast corner of Lake and southern portion of South Chicago. The rocky trough by South Branch and Ogden Ditch through which the ancient river flowed is well marked and everywhere eroded and scratched.

It would be foreign to our purpose to give the theories which relate to the formation of this river and the fluctuations of level in the lake which have caused its abandoment.*

When Lake Michigan assumed its present level a succession of mud lakes was left along the old river channel, the South Branch was converted into a currentless bayou, and for a mile in width from the present city limits at Bridgeport, to the mouth of the river, the surface of the ground was left at but little, if any, above the level of the lake.

Parallel to the old channel, from River Side to near Bridgeport, was its northern bank, occasionally marked by outcrop of Niagara limestone. Near Bridgeport the outcrop bends to the north following about the centre line of the West Side to Milwaukee Avenue where the outcrop disappears. Swinging northeast by Clybourne Place, crossing Fullerton Avenue near Clark St. and appearing in the lake opposite the upper end of Lincoln Park the rock is found at an average depth of twenty-five feet below datum.† To the right of this line the rock dips to east and southeast. To the left, mostly horizontal, especially on the northwest. It will be seen that considerably more than half of the city is in a sort of basin or dipper with the handle to the southwest at Bridgeport. Everywhere in this basin is a bed of clay of the boulder dritt, 40 to 100 feet thick. This clay also overlies the rock to the northwest where not derinded by surface action. This clay is very compact, stratified, containing pebbles and occasional pockets of sand and water. The Niagara limestone on which it rests to the west and northwest is somewhat siliceous, saturated with petroleum, solid nodules of bitumen being abundant and also occasional cavities containing more or less petroleum and gas. The susface as laid bare at Fullerton Avenue is broken down and polished as smooth as a house floor with well marked parallel scratches southwest by west, showing in a beautiful manner the work of the glacial period.

About a mile from its mouth the Chicago River divides, the South Branch, previously described, draining about forty square miles, and the North Branch, rising to the north in sloughs and low prairie, draining about eighty square miles.

The presnt area of this city is about thirty-six square miles. Throughout all this basin, over at least one-third of the city, the original level was but little above the lake, overflowed at times of high water or during a northeaster. This basin had also many mud lakes and sloughs; one slough of particular note on the West Side, extending parallel to the line of outcrop from north to south, which probably marks the old channel of the N. Branch when the old outlet was open.

The South Side, near the city limits, being part of the rocky island previously alluded to, is high and dry; also, along the lake shore on both the South and the North Side for several blocks in, except near the mouth of the river, the sand has blown from the beach in recent times leaving nothing to be desired. These are really the only parts of Chicago that originally could be considered as anything more than a swamp or slough, for although back of the escrapment of rock on the West Side, to the city limits, the surface is sixteen or eighteen feet above datum, it was wet prairie overflowed in the spring, and is marked swampy even on the Lake Survey Chart of 1872.

On such a site has Chicago grown and prospered. Starting in 1830 from an old Indian trading post, (Fort Dearborn on the South Side near Rush St. bridge) her population consisted of seven families. In 1850 this had increased to a population of 29,963 souls. Until 1860, when the population reached 109,206, the city was regarded as merely an overgrown village, chiefly of a speculative character, consisting for the most part of frame buildings. No inhabitant expected to make more than a temporary residence, and travellers after viewing its site left in disgust. But to its repulsive site, on the low portage between the lakes and the Misssissippi basin, its first prosperity was due. At that time a new impetus seemed to seize the city; confidence as to its ult mate prosperity was strong, and in this Centennial year Chicago boasts of a population of at least 500,000. Really the metropolis of the West, holding the key between the Mississippi valley and cheap transportation by way of the northern lakes, she promises always to be its chief city.

Her public works are second to no other American city in number and magnitude, and have been able to barely keep pace with the needs of her growing population and commerce. The credit of the design and execution of these works belongs almost, if not quite wholly, to Mr. E. S. Chesbrough who has been her City Engineer for the past twenty years.

The sluggish river and its two branches, its bed in clay and a sand bar across its mouth, of less than three feet depth of water, have been dredged out sufficiently for the largest lake vessels, and at the present writing Chicago has a dock line of about thirty miles, and a harbor of refuge on her lake front protected by a crib sea-wall enclosing an area of 400 acres.

The level of the streets in at least one third of the city have been or are being raised to a uniform grade, amounting in that portion near the river to eight feet; 410 miles of water mains have been laid. In 1867 the 5-ft. tunnel extending in the clay two miles under the lake was finished, giving the city 50,000,000 gallons of water daily. A second tunnel, 7 ft. in diameter, running parallel to the old one to the same crib, two miles, and extending four miles under the city, to Bridgeport, was completed in 1875, increasing the water supply to 150,000,000 gallons daily.

At the present writing Chicago has 263 miles of sewers. Owing to the peculiar site of the city it has been possible to give very slight inclination to these sewers and nearly all have to be cleansed artificially. These sewers except in a few instances on the lake front discharge their contents into the main river and branches. This together with the numerous slaughter houses, glue factories and dye houses on the South Branch, and distilleries, breweries and gas works on the North Branch, pouring incessantly their filth into a currentless river, converted it simply into an elongated cesspool, the stench from which was simply horrible. This was particularly the case in the spring of the year when the ice had melted, exposing to the sun the accumulations of a winter, and also during a dry summer when practically no water found its way into the two branches from their drainage areas. An early spring freshet remedied this to a certain extent, and occasionally a summer rise would leave the river comparatively pure. Sometimes a southwest wind would so lower the water on this shore of the lake as to create a current from the river and partially discharge its sewage. In one such case the effect of the sewage on the water of the lake was detected along the shore five miles to the north and three miles to the south when the accumulations of a winter were spued out But such agencies were far from reliable and often entirely failed for a season when the stench would become unbearable. Notwithstanding that Chicago is almost constantly fanned by lake breezes and is a city comparatively healthy considering her site, it became evident at an early day that some means of abating the nuisance must be adopted. Lake breezes could not always contend against such odds, and zymotic disease had begun to tell its tale in the death rate.

The city fathers discussed various methods of remedying the nuisance at an early day, and passed sundry laws to prevent the the pollution of the river, but of no avail. The Illinois & Michigan Canal Company had established pumps at Bridgeport to supply the summit level (7.5 feet above lake level and 25 miles long) of the canal, when the Calumet feeder failed them in dry seasons. When these pumps were operated relief was experienced in the South Branch, and for several years when the state of the river became unbearable the city kept these pumps in motion, discharging the sewage via. the canal into the Illinois River.

This at best was but a temporary expedient, and various methods of permanent relief were discussed in the City Engineer's Report for 1863. The plans discussed were divided into three classes,—"1st, those which would drain the city into the Illinois River; 2d, those which would direct the Des Plaines into the South Branch of the river, and thus keep up a constant current to prevent offensiveness, and 3d, making a canal from the lake to the North and South Branches, and driving water enough through them from the lake to keep the river and branches comparatively pure at all times."

The 1st was not recommended on account of expense; the second was liable to fail in a dry season when most needed; the 3d was practicabie, under control of the city, and effectual. The Bridgeport pumps gave sensible relief in '61 and '62 when pumping 200 cu. ft. per second. It is now proposed to drain into the lake through a covered canal or conduit 12′ in deameter 400 cu. ft. of water per second. This amount would be sufficient in less than twenty-four hours to change all the water in the South Branch and main river to its mouth. An engine of 100 horse power, pumping under 1¼ ft. head, would accomplish this result. Accordingly a conduit was recommended, to be located on North St. (now 16th), to cost $140,000. In report of 1864 the immediate construction of the North St. sewer was urged.

The scheme, however, was not adopted, and in 1865 a commissioh of six engineers was appointed by the Common Council to consider and report upon the best plans for cleansing the Chicago River. All the plans discussed may be embraced under three general heads:

"1. Intercepting sewers, which shall receive the filth that would otherwise flow into the river and carry it to the lake, to some point or points into which it would be pumped by machinery—thus keeping impurities out of the river to as great an extent as practicable."

This plan was not recommended for the reason that it would be unsuited to the requirements of Chicago and without close surveillance and great caution would be a source of constant expense.

"2. Cutting canals or making covered sewers from the two branches of the rivers to the lake, and, by pumping works erected thereon force the filthy water out, or the lake water in, thus keeping up a constant current to keep the river pure."

This plan was regarded as of the least immediate expense and the most effectual. Accordingly an open canal from the South Branch to the lake, through or near Douglass Avenue, was recommended of the following dimensions: length, 13,700 ft., width at bottom, 25 ft., at surface low water 65 ft., depth, 10 ft., cost, $547,230; also an open canal of same dimensions on or near Fullerton Avenue 11,200 ft. in length, cost, $469,269.

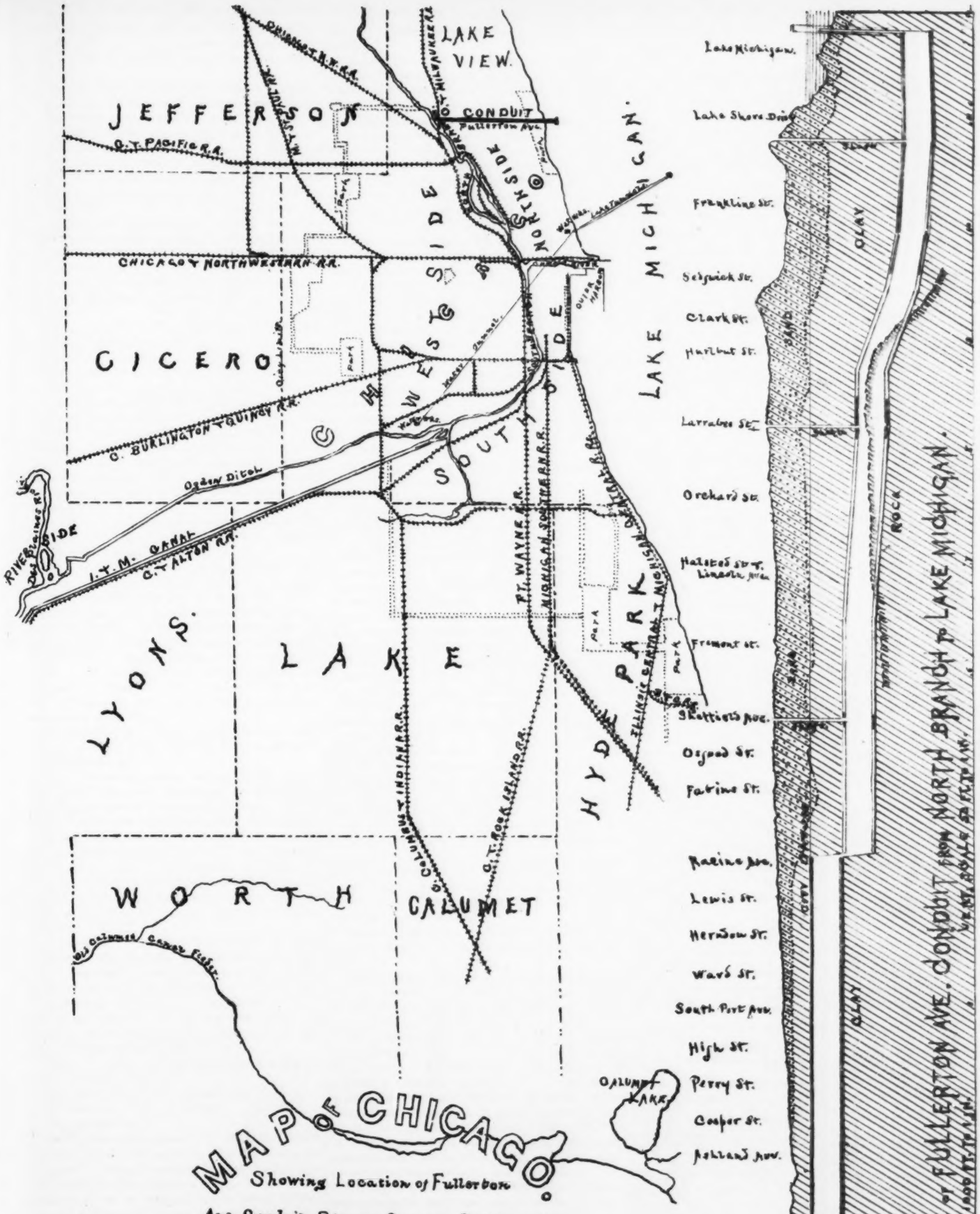
"These canals would have a capacity sufficient to discharge 24,000 cu. ft. per minute, each (without raising it more than 4') which, it is supposed, would change the entire volume of water in the river in forty-eight hours.

The machinery for pumping might be placed either upon the river or lake ends of the canals." The disadvantages were,— accumulated filth discharged so near the city and the constant expense of keeping them open into the lake, and for pumping.

"3. Cutting down the summit of the Illinois & Michigan Canal below the level of the lake, so that a sufficient quantity of water may be drawn from it to create

* For the various theories the reader is referred to "Transactions of Chicago Academy of Sciences," Vol. II, 1875; No. 197 "Smithsonian Contributions to Knowledge," and Part II of report on "Minesota River" by G. K. Warren, 1875.

† Datum is about two feet below mean level of the lake.



ENGINEERING NEWS JULY 1, 1876.

the necessary current through the main river and the South Branch (and perhaps, to some extent in the North Branch also) to thoroughly purify the same at all times."

"The estimated cost of the third plan for purifying Chicago River, which is to cut down the summit of the canal below the level of the lake, so as to draw from it at a low stage, not less than 24,000 cu. ft. of water per minute, is $2,102,467.50."

"This estimate provides for increasing the capacity of the canal somewhat over the plan adopted by the canal commissioners in 1836, so as to create a current in Chicago River which is deemed sufficient to cleanse it, etc." The reasons given were that it was the only possible means of cleansing the main river and South Branch continually for all time, the lake would not be contaminated, the first cost would be the only expense to the city as it would be maintained by the State and it would be part of the expense of a future enlargment to a ship canal.

Turning the water of the Des Plaines into the river was not considered satisfactory.

At this time the Illinois River Improvement by slack water navigation so as to give 7½ ft. of water from its mouth to Peru, and ultimately its enlargmegt to Chicago so as to allow the largest Mississippi boats access to the harbor of Chicago was actively in the public mind and accordingly the commission unanimously decided in favor of taking out the summit level of the canal as a part of the scheme. An act was passed by the State to give the city a lien on the canal and its revenues for $2,500,000 with interest until paid, the city to furnish the capital to deepen the canal.

In 1871 the improvement, after many delays, was completed, and on July 15, the waters of Lake Michigan were turned into the Illinois River.

The total cost of the work was $3,300,000 in round numbers. The length of the through cut was twenty-six miles, about half of the distance being rock. Average cut from bottom of old canal, about 10 feet. Width of bottom 48 feet, slopes 1 to 1; minimum depth of water 7½ feet. This level now extends from Bridgport to Lockport, a distance of 30 miles, having a fall on the bottom in that distance of 3 feet; calculated to discharge in periods of low water at least 24,000 cu. ft per minute.* The moneys advanced by the city have since been repaid by the State.

The effect was immediate, a constant current setting through the South Branch restoring it to a condition of comparative purity.

Private parties interested in land speculation had cut the Ogden & Wentworth Ditch from the Des Plaines, thus turning a considerable quantity of water into the South Branch at the head of the canal which, to that extent, has nullified the aciton of the canal in removing the polluted water and deprived the city to a certain extent of the benefit of this improvement. At certain periods of water this ditch may be said to feed the canal, leaving the river currentless. Steps are now taking to head off this nuisance by a dam at the Des Plaines River.

As pointed out by the Chief Engineer previous to its completion, whenever the North Branch by freshet should discharge its sewage it would simply pass the length of the city by the South Branch. This is found to be true, and together with the Ogden Ditch the South Branch is occasionally polluted to a great extent. In 1870 the City Engineer urged the adoption of some plan to improve the North Branch.

The various plans proposed were classified as follows:

1st. Intercepting sewers.

2d. Canals between the river and lake.

3d. Reservoirs high up the river.

4th. Artesian wells.

These plans were discussed at considerble length. The first system could cost no less than $3,000,000, and at present no definite conclusion had been reached as to the availability of any system of sewage utilization. No available site for an irrigation system existed within a reasonable distance of Chicago that might not be needed for building purposes at no distant day. This coupled with the fact that no irrigation scheme would be available in a climate where the ground was frozen nearly one-half the year did not seem to warrant its farther consideration.

The third system was rejected as impracticable on account of the great reservoir area required; when the water from this area was drawn off the exposed surface would be very deleterious to health; great expense, and uncertainty as to its accomplishing what was required.

The fourth system would require 450 artesian wells, and the uncertainty in regard to the supply of water holding out under such a draught vitiates the scheme.

In speaking of the second plan the City Engineer says: "The result of investigation as to what the city has the power at present to do, leads to the recommendation of a covered canal or conduit, circular in form and 12 feet internal diameter, on the line of Fullerton Avenue with the reqvisite machinery for pumping or driving water in either direction, near the North Branch.

"Such a canal would be two miles long and with a bottom 14 feet below low water and a head of 4½ feet, could be made to discharge 24,000 cu. ft. of water per minute, or sufficient to change all the water in the North Branch and the main river every thirty-six hours.

"The estimated cost of this canal is $480,000 including machinery. The machinery recommended is a 300 horse power engine and a propeller wheel so placed as to draw or drive water in the direct line of the canal." On account of the discharge of the river going down the South Branch, the conduit should be made to discharge into the lake. †

The views of the City Engineer in urging the adoption of the Fullerton Avenue conduit are of interest in connection with future works that may be needed.

"In view of present knoweledge and experience, it does not seem advisable to commence the construction of a system of intercepting sewers just yet, though the probability of having to do so ultimately seems rather to increase from year to year. More time seems to be needed to determine upon all the conditions that should be required of such a system.

"1st. It could be made to discharge either into the lake or the river, as circumstances might require. During wet seasons, in spring and fall, nothing is needed besides the natural flow to cleanse the river. An artificial current from the river to the lake would be needed when that of the river was very slight, and in the opposite direction when the natural discharge from the North Branch was too great to be overcome by the amount the canal could discharge into the lake, and yet not strong enough to cleanse the river.

"2d. It could be made the outlet for a system of intercepting sewers for the northern portion of the city, supposing the limits to be extended by farther legislation several miles farther north.

"3d. It would afford a very convenient and economical outlet for the sewers of a large part of the district to be annexed to the city north of the present limits, between the lake and the river. It is doubtful if, in view of the probable future growth of the city, a better location could be selected for the outlet of a northern system of intercepting sewers."

The second plan as recommended by the City Engineer was adopted. We shall speak of it at considerable length.

Although the condition of the North Branch has continually grown worse with increasing population, its improvement has not been pushed with vigor, we fear not so much from a short sighted policy as on account of the spoils. The continuance of the river in its present condition together with the Ogden Ditch largely vitiates the benefits from the South Branch Improvement. To a person who has ever had the benefits of the gentle zephyrs which are often wafted from the bosom of the North Branch its continuance in its present condition seems simply disgraceful. The writer remembers seeing a newly painted propeller in the spring of '75 coming from an elevator on the North Branch as black as sulphuretted hydrogen can make lead paint.

Through temporizing with contractors and an indecent regard for public health the work is not yet finished. There is no reason why it cannot be completed in time for another season, and it is to be hoped that those in authority will pursue a liberal policy toward a work which, in consideration of public health alone, demands an early completion.

Bids were invited at the beginning of 1874. We give so much of the specifications ss will enable the reader to understand the nature of the work.

SPECIFICATIONS.

LOCATION AND GENERAL DECRIPTION.—The portion of the conduit to be constructed in accordance with the following specifications, is to extend along the center line of Fullerton Avenue, from the east bank of the North Branch of the Chicago River to the shore of Lake Michigan; being about eleven thousand feet in length, more or less.

The conduit will be divided into two sections; section 1 extending from the North Branch of the Chicago River to the west line of Fremont street, being sixty-two hundred feet in length, more or less.

The greatest depth of excavation on center line of street being 31 feet; the least 22 feet, and the average 26½ feet.

Section 2, extending from the west line of Fremont Street to Lake Michigan, being forty-eight hundred feet in lengtd, more or less.

The greatest depth of excavation on center line of street being 40 feet; the least 18 feet and the average 32 feet.

The conduit to be circular in section, with an inside diameter of 12 feet. It is to be level throughout, with the inside surface of the invert 13 feet below city datum.

There is to be a man-hole at each street crossing, and at other points shown, provided with junctions or entrances for sewers, as shown on plan "C."

EXCAVATION.—The nature of the material to be excavated, so far as the same could be ascertained from numerous borings made, is shown on the accompanying plan, marked "A." But the contractor must take the work at his own risk, with regard to peculiarities of soil which may exist at points between or on the sides of the borings.

The excavation to be made to a depth of twelve inches below the bottom of the masonry wherever required, and with but two lengths of sheeting, in a manner substantially as shown on the accompanying plan, marked "B."

Where the elevation of the surface above city datum exceeds 16 feet the excavation of the excess is to be sloped back without sheeting, the foot of each slope to stand 12 feet, measured horizontally, from the center line of the conduit.

From an elevation of 16 feet, to an elevation of 2 feet above datum, the excavation is to be 22 feet in width, and closely sheeted and braced. From an elevation of 2 feet to the bottom of the invert, 14½ feet below datum, the excavation is to be 19 feet in width, thoroughly sheeted and braced. * * *

THE CONDUIT PROPER.—The conduit is to be built of brick masonry 16 inches in thickness.

The masonry is to be of hard-burned, clear-ringing and well-formed bricks, free from lime, of the usual size used for construction of sewers in this city.

The bricks to be laid in the best cement mortar, in four rings or shells, to lie longitudinally with the conduit, with the edges toward the center, and with toothing joints. The cement to be equal to that known as the best Clark's LaSalle, of past years, and not merely the best that may happen to be in the market for the time being. The mortar to be made by mixing two measures of clean, sharp sand with one of cement, and used as soon as possible after being mixed.

The bricks must be clean, and thoroughly wet if required, before being laid. Those having smooth surfaces to be used on the inside face of the conduit, and to be laid fair and smooth by line, and to a true cylindrical form.

All the joints in the masonry must be perfectly filled by pressing the brick into the cement mortar, and not by pressing the mortar between the bricks.

The joints between the courses shall not exceed half an inch in thickness, and between the rings or shells they shall not be less than half an inch in thickness.

All the mortar joints to be carefully struck, and smoothed with the surface of the brick; all the refuse mortar to be scraped off, and with the rubbish of every kind and description to be removed entirely from the conduit, which must be left perfectly clean. Wherever the soil is sufficiently firm, the masonry for the conduit is to be laid directly on the bottom of the excavation; but wherever this shall not be the case, the contractor shall put in place sand, gravel or other suitable material, as may be required by the Board of Public Works.

Sufficient means must be provided to keep the work dry until the cement is perfectly set.

MAN-HOLES.—There will be in all 23 man-holes. One at the intersection of each street, and at other points. * * *

SPECIAL AND GENERAL REQUIREMENTS.—The contractor must deliver to the Board of Public Works, on or before the first day of each month, a written statement of the amount of claims if any, for extra work done, and extra materials furnished during the previous month, otherwise, claims for extras during that month will be forfeited.

The contractor will be required to keep the work in perfect repair for twelve months after the same shall have been faithfully completed, to the satisfaction of the Board of Public Works. Monthly estimates will be made by the Board of Public Works, of the value of the work actually done and in its permanent place, and on or about the sixth day of each month, vouchers for eighty-five per cent. of the estimated value of the work done the previous month will be issued, the remaining fifteen per cent. being reserved as security for the faithful completion of the whole work. * * * * * * *

The whole of the work included in these specifications to be commenced and carried on at such times and places as said Board shall direct, and to be completed by the first day of May, 1876.

Bidders may propose for one or both of the sections specified, at their option.

The following bids were received:

Bidders.	Sec. 1, per ft.	Sec. 2, per ft.	Total.
Geo. F. Norris	$28 14	$35 17	$343,284
McClellan & Smith	31 16	37 27	372,088
Clarke Lipe	30 94	31 98	372,272
Jas. K. Lake	29 47	39 95	374,774
J. L. Cook	31 52	37 04	373,216
David Murphy	29 74	42 00	385,988
Fox & Howard	32 24	39 54	388,240
Ed. F. Door	29 00	43 50	388,600
L. L. Leach	32 00	40 00	390,400
Cox & Walker	31 50	43 50	404,100
Thos. Nicholson	30 24	45 00	403,488
Fitzsimmons & Connell	32 24	42 83	405,472
M. McNichols	34 00	45 00	426,800
Chas. Gladding & Co	34 50	46 00	434,700
C. W. Fuller	34 00	50 00	450,800
D. Hallaum	32 00	37 00	472,000
D. F. Minnahan	34 60	54 00	473,720
Lancaster, McMahon & Steel	34 70	54 00	474,340
J. & J. H. Duffy	33 20	56 40	476,560
J. H. Carpenter	41 00	47 75	483,400
John McHugh	32 50	59 00	484,700
Robert Stewart	42 50	50 00	503,500

It was the opinion of the Board of Public Works and

* It is ultimately intended to give it a width of 160 feet. The locks on the lower river are 75 feet in width and 350 feet in length. Two of the five locks and dams are now completed.

† A navigable canal on Fullerton Avenue was considered, but not seriously; also a canal 2½ miles farther north at Bowmanville. Probably at no distant day this Bomanville canal will be constrncted, as the ground between that place and the lake is very favorable and the distance less than 2½ miles.

the City Engineer that the work could hardly be done for the lowest bid, and Geo. F. Norris & Co. were so advised. But they seemed anxious and ready to execute the work, and their bondsmen being thoroughly responsible, the work was let to them for the sum sbecified in their bid.

The work was commenced in May, 1874, and about 4200 feet of the west end, extending from the North Branch to 40 feet east of Racine Avenue, completed in essentially the manner provided for in the specifications. This portion comprised the easiest part of the work, and for it the contractors were paid $103,226.59, this being the total sum due omitting the 15 per cent. as reserved by contract.

At this juncture the contractors asked to be released from their contract, claiming that the soil was much more difficult than what they had figured upon and that they should have a bonus toward damages for injury to plant, balance due for work, etc., amounting in all to $53,000.

The petition was referred to the Board of Public Works who reported unanimously againsi it, stating that the relief asked for would make the cost in excess of the highest bid and that several bidders next in price above Norris & Co. were willing to finish the contract at the price stated in their respective proposals, notwithstanding the fact that the most profitable part of the work was completed, etc.

Before the Grand Jury in the spring of '76 it was stated as the belief of several contractors that the work could have been executed at a fair profit, if properly handled.

In the city report for 1875,—"The contractors, Geo. F. Norris & Co., refuse to resume construction on the ground that the work was of a different character from that which they had agreed to do. The Board could not concede the reasonableness of their claim, and the contractors appealed to the Common Council. It is hoped that your honorable body will sustain the Board, and refuse to set so dangerous a precedent as that of allowing contractors to break their agreement with the city, at the public cost."

Notwithstanding, the Common Council referred the matter to a committee consisting of Mayer Colvin, Comptroller Hayes and Corporation Council Dickey, who reported an ordinance to the council which was immediately passed. This ordinance is so remarkable a document that we give it in full:

ORDINANCE.

SECTION 1. That upon the execution and delivery by George F. Norris & Co. to the city comptroller of a sufficient release of all claims and demands af every nature and kind upon the city of Chicago, the mayor and comptroller are authorized and directed to pay them the sum of $50,430.56, from the money appropriated for cleaning the North Branch of the Chicago River, and to draw their warrant on the treasurer therefor; provided, however, that the appraised value of the plant of said G. F. Norris & Co. shall also be retained for them as hereinafter set forth.

SEC. 2. Before the Board of Public Works shall advertise for proposals for finishing the Fullertod Avenue Conduit they shall cause the value of the machinery, cars, lumber, and other property belonging to G. F. Norris & Co., and lately used by them in the prosecution of the work on said conduit, and commonly known as the "plant," to be appraised as follows: Said Board shall select an appraiser and G. F. Norris & Co. shell select one, and the two thus chosen in case of a failure to agree shall select a third, who shall certify the appraisement with a list of the property appraised to said Board of Public Works, and whenever said Board shall let the remainder of said work they shall insert in the advertisement for proposals therefor the condition that the successful bidder will be required to take said "plant" at the said appraised value, and shall insert into the contract entered into by the successful bidder that the said bidder will take said "plant" at said appraisal, and that the amount of the appraised value thereof shall be retained by the city of Chicago, out of the first estimates on the work done, and paid over to said G. F. Norris & Co., and credited to said city of Chicago as so much paid to said subsequent contractor cr contractors upon their estimates, and the comptroller upon the proper voucher of said Board of Public Works shall pay over such money so retained on account of said "plant" to said G. F. Norris & Co. from time to time, until the whole of said appraised value shall be paid, and no part of such estimates shall be paid over to such subsequent contractor or contractors until a sufficient amount to pay for said "plant" shall have been retained.

Passed June 14, 1875.

This amount also included the 15 per cent. which should have been retained by the city for neglect to fulfil the contract. The rest was a simple gratuity as the character of the land was every way more favorable than could have been anticipated from the profiles submitted.

The plant was fairly appraised at $24,587.95, but being of very little use to subsequent contractors was simply added by them to their bids. So in fact the city was robbed of $75,018.51 to which they had a legal and moral right, to say nothing of indirect damages.

Paid Norris & Co. by city $153,657.15, or $36.561 per ft. on 4200 feet constructed. If $24,587.95 be added to Norris & Co. and deducted from subsequent contractor the price per ft. will be 42.44.

[TO BE CONTINUED.]

Contractors' Intelligence.

The iron bridge at Le Sueur, Minnesota, has been completed, and is open to travel.

The corner stone of the New Court House for Winnebago County, Ills., was laid at Rockford on the 23d ult. with appropriate ceremonies.

The material for a new bridge across the Vermillion River, a half mile north of McDowell, Ill., is on the the ground, and work was to have been commenced last week.

The American Bridge Company have just received the contract for furnishing the entire iron work, above the first story, for the new U. S. Post Office and Sub-Treasury Building, in this city.

The Wrought Iron Bridge Company of Canton, Ohio, have recently been awarded contracts for seven of their bridges by the commissioners of Allegheny County, Pittsburgh, Pa. The bridges average from forty to fifty feet span.

The contract for furnishing the materials and constructing the New Haven side of the abutments and wing walls of the West River Bridge was awarded to Maurice J. Reilly, of New Haven. Conn., on the 22d ult. for $7,312.

The contract for laying pipes and supplying Napanee, Ontario, with gas works has been awarded to Mr. D. McMartin, of the Canadian Gas Lighting Company of Montreal, for $21,750. The gas will be manufactured from coal oil.

Contracts for building sewers for the city of New Haven, Conn., were awarded by the authorities of that city on the evening of the 22d ult., as follows: To Lawrence O'Brien, for the sum of $4,048.50, and to Davis & Fowler for $2,198.75.

The abutment and wing walls for the new bridge on the Orange side of West River, Conn., are being constructed by day work under the supervision of the town authorities, both abutments being built according to the same general plans and specifications.

The Hampden, Mass., County Commissioners have given the contract for building the abutments and piers of the new iron bridge across the Connecticut just above Hampden Park, to Beattie & Dresser, of New York, for $68,066. The work is to be completed by December.

The Board of Bridge Commissioners of New Haven, Conn., have notified the contractors, Messrs. C. H Parker & Co. of Boston, to proceed at once and complete the work on the new Euinnipiac Bridge. If the work is not commenced within a specified number of days, the Commissioners will employ others to do the work at the expense of the contractors.

The contract for building the Chicago, Milwaukee & St. Paul Railroad Bridge across the Mississippi River at La Crosse, Wis., was awarded last week to the American Bridge Company, of Chicago, for $92,735. The Pratt-truss bridge was selected, and the award was made to the lowest bidder for that pattern of bridge. The contract calls for its completion Dec. 1st.

The Massillon Iron Bridge Company, of Massillon, O. was awarded the contract, on the 17th inst., for the construction of a heavy truss bridge, at Niles, Trumbull Co., O. It is to consist of one span of 154 feet, and clear roadway of 16 feet. This company was also awarded on the same day the contract for a 120 feet span arch bridge over Tonawanda Creek, near Tonawanda, N. Y.

The contract for the excavation and removal of material from the inner harbor, and the main branch of the Patapsco River at Baltimore, Md., has been awarded to the Morris & Cummings Dredging Company of Baltimore and New York. The *Baltimore Gazette* of the 24th ult. says: "This company has done work for the government in the Chesapeake Bay, and has also excavated 500,000 cubic yards under the Patapsco River Improvement Act during ex-Mayor Vansant's administration. The contemplated improvement will necessitate the removal of 2,000,000 cubic yards, for which the city will pay 10½ cents per yard. The sediment is to be dumped outside of Sollers' flats, or at the fifteen-mile dump, as the board may direct. The bids for dumping at the sea wall were not considered, being too costly. The contemplated improvement will deepen the basin 19 feet from South street to the foot of Hughes street, and the whole distance along the wharves on the north and south sides, this depth being that at mean low tide. There will be a channel twenty feet deep from the foot of Hughes street running to Locust Point, three hundred feet wide, on both sides of the basin. A full channel on the Middle branch of the Patapsco twenty-four feet deep and one hundred and fifty feet wide will be dug from Winans' upper wharf to the main ship channel below Fort McHenry."

NOTES.

The sponges of France yield $240,000 a year.

A large furniture factory is about to be established in Toronto, Ontario.

A Splendid collection of British fossils has been added to Tufts' College, Mass.

England has imported in the past four months $1,845,685 worth of petroleum, against $685,720 worth in 1875.

The Grand Rapids and Indiana Railroad Co. has sunk a shaft ninety feet, in exploring for coal on its lands adjoining Big Rapids, Mich.

Many of the business men of Philadelphia have determined to close their stores and offices early in the afternoons of July and August, to permit their employes to visit the Exposition.

The Welland Canal from Part Colborne, on Lake Erie, to Port Dalhousie, on Lake Ontario, will have, when the enlargement is completed, 22 locks 270 feet long between gates, 40 feet wide with 15 feet of water on miter sills. The improvement will be completed in about two years.

May E. Smith, Assistant Engineer of South Pass Jetty Works, has written the following letter to Capt. Eads, dated June 6th,—"I find that the total scour between the jetties amounts to full 3,000,000 cubic yards. The scour last month was 140,000 yards. All that remains to be removed for a connected channel twenty feet deep and two hundred feet wide is 23,000 yards."

The Chinese are masters of a process which, so far as known, is not practiced by any other people, for covering plates of sheet lead with thin layers of colored glass. With these sheets the domes and sides of their temples are plated, giving them a singularly lustrous and gorgeous appearance. Specimens of this glass-covered lead are in the hands of French glass manufacturers, who hope to discover the secret of the process.

After a sufficient comparative trial, the contest between granite, asphalte, and wood for carriage-ways has been decided in favor of the last, and the recent conclusion of the Corporation of London may be regarded as a final confirmation of that decision. Mr. Heywood, Engineer for the city, has shown that before a horse falls he may be expected to travel on granite 132 miles, on asphalte 191 miles, and on wood 446 miles; and although between the last two materials there is a trifling andantage in cost on the side of asphalte, that is much more than counterbalanced in other ways. In easy traction and the absence of noise there is no comparison between wood and granite, and since the surface water has been kept out by means of asphalte, wood has become one of the most durable of pavements. The rapidity with which it can be laid and the ease with which it can be repaired are not the least of its merits, while the flooring of planks, which is now laid as a superstructure, gives great elasticity, and by distributing the weight equally over the whole pavemeut, adds to its power of endurance.—*Iron.*

Submarine Telegraphy.

(From L'Electricite.)

From 1850 to the end of 1874 the number of telegraphic cables actually submerged was 206, representing a length of 80,000 kilometres (about 49,000 miles.) Of these 206 cables, 61 have ceased to be of any use, and 145 are still working. England and France are the two countries which possess the most submarine cables. England has twenty-nine and France sixteen. France and England are themselves bound together by seven telegraphic cables.

In 1850 and 1851 but two submarine cables were laid down. This magnificent enterprise was then in its in-

fancy. In 1852 and 1853 eight cables were submerged, in 1854 seven, in 1855 nine, in 1856 and 1857 one each year, in 1858 five, in 1859 thirteen, in 1860 twelve, in 1861 one, in 1862 two, In 1863 one, in 1864 six, in 1865 three, in 1866 ten, in 1867 seven, in 1868 two, in 1869 seventeen, in 1870 twenty-seven, in 1871 twenty-six, in 1873 fourteen, and in 1874 thirteen.

Among the longest of these submarine cables are—that which runs from Ireland to Newfoundland, which measures 1920 miles; the cable from Ireland to the coast of St. Vincent at Pernambuco, about 1950 miles; and that from Brest to St. Pierre, about 2570 miles. France, therefore, has laid beneath the sea the longest cable known.

The greatest depth of immersion of cables is as follows:—The cable between Malta and Alexandria lies at a depth of 13,800 feet; that between Ireland and Newfoundland, 17,700 feet; that between Portkarno in England, and Lisbon, 18,000 feet; that between Brest and St. Pierre, 11,370 feet. Before 1851, the era when the first transatlantic cable was laid, no cable of a greater length than 350 miles was in existence. After having been in use but a month, the first transatlantic cable broke. This was a serious check; but it had been proved that the ocean could be spanned by an electric wire.

The conception of the project of a transocean telegraph is due to an ingenious American, Mr. Cyrus W. Field. In 1865 the Congress of the United States gave a vote of thanks and a gold medal to this gentleman. He also obtained the "grand prize" at the International Exposition of Paris in 1867.

It was not until 1870 and 1871 that direct communications were established between England, India, China, Japan and Australia. At present it only needs to lay a cable at the bottom of the Pacific Ocean in order to surround the globe with a complete girdle of electric telegraphy, according to the dream of Mr. Field. The total length of the Pacific cable would be about 5,-540 miles, divided into three sections—From San Francisco to Honlulu, 2087 miles; Honlulu to Midway Island, 1164 miles; from the last mentioned place to Yokohama, 2289 miles.

Eleven new cables are, at the present writing, in course of construction, having a total length of 17,000 miles. The largest ones will connect Ireland and New Caledonia, 3178 miles; Aden and the Mauritius, 2,777 miles; and Honolulu and the Fiji Islands, 2,876 miles. The strength and endurance of submarine cables depend upon the depths to which they are submerged and the nature of the ocean bottom upon which they rest. If there are rapid currents and a rocky bottom the cable must be made very solid and heavy. The cables of the Anglo-American Company cost 5,000 francs per kilometre (.62 of a mile,) for those which lie in the depths of the ocean, but those for nearer shore cost 16,000 francs per kilometre. The cables between England and Hol and are constructed almost through their entire length on the model of the inshore transatlantic cables, because the water the whole distance is comparatively shallow, and never exceeds thirty fathoms. Of course their cost was heavy.

There are sixteen companies of submarine telegraphy with a capital of upwards 500,000,000 francs. The principal is the Anglo-American Company, which possesses five cables and a capital of 175,000,000 francs. The Eastern Submarine Telegraph Company has a capital of 75,000,000 francs The Eastern Extension, Australia and China has a capital of 41,500,000 francs. The Western and Brazilian has a capital of 33,500,000 francs, The West India and Panama Company has a capital of 47,500,000 francs.

There can be little doubt that the tendency of the lines is to the unification of the telegraphs under the governments of the respective countries wherein they are located. The vast extension of the telegraph cables leads to the expectation that a still further consolidation of interests will be effected, and the telegraphs of the world will finally be placed under the control of an international commission.

Contractor's Plant.

BY ALEXANDER CLARK.

Paper read before the Edinburgh and Leith Engineers' Society

Gentlemen,—We trust it will not be necessary to make any very elaborate apology for bringing this subject before you, and that although it is one in which, as a rule engineers are not called upon to advise, they will nevertheless willingly admit that the construction of the implements employed in carrying out engineering works is of considerable importance. We have, indeed, calculated on your prepossession in its favor, and trust your ample indulgence will extend both to the writer and his subject. We are aware that scientifically it has not the interest attaching to many subjects of engineering, and that a paper on "plant" must in a measure be disjointed and incoherent from the great diversities in the details which call for notice. It is not however on that account necessarily uninteresting or unimportant, as we often find that the *method* of construction is the source of considerable modification in the design. Further, and without attaching undue importance to our subject, we believe that the success of many undertakings is in a great measure dependent on the construction, quality and number of implements used in carrying out the work. Even in cutting out a small trench or ditch no doubt you have observed how time is lost, and the work made costly, from the entire want, or the awkward construction of a small windlass for lifting a boulder from the bottom of the excavation. A slip of the sides may be the consequence of this delay, and should pipes require to be laid or an acqueduct built in the trench, the hasty manner in which these operations are performed, so as to save further mistakes, is greatly to the disadvantage of the quality of the workmanship. Much more then is the loss in extensive works where large quantities are to be dealt with, and a temporary derangement of a single machine may cause inconvenient delay, and involve considerable expense.

In looking over the wide field of subjects which may be included under the name of "plant" it is difficult to know which to select so as to compress within a single paper matter which may be interesting without too severely taxing your patience. In the remarks we intend to make we shall not attempt to describe any of the more recent inventions which appear destined to create a revolution in the contractor's plan of operations, but confine ourselves to the more common implements and machines, which, notwithstanding all our familiarity with their appearance, are perhaps less known to us in their details. With patent excavators, boring machines and such like, we are acquainted from the descriptions we read every week in the leading engineering papers, but before the picks and shovels and wheelbarrows and wagons of the old contractor's days shall have passed away, and their types been forgotten, we shall with your permission and indulgence call your attention to the construction and use of a few of the most common implements and machines used on water, sewerage, railway and dock works. Had space permitted we should have endeavoured to place before you an estimate of the cost of the implements to be described and the percentage on the price which is required for them, but this must in the mean time be set aside, as we find the former part of the subject far to large to treat as we desire.

In referring to the implements used in contractors' work we shall first advert to the hand tools, because in most cases these will not vary with the nature of the contract.

Picks, etc.—The size and strength of an average man give the true proportions of these implements, which should be well made of the best materials, and little scope although there may seem to be for ingenuity in their manufacture, yet we find great varieties as also diversities of opinion in regard to them. A properly formed solid eye is the first essential in the manufacture of a pick, and the point is varied to suit the materials to be excavated. For ordinary soils the diamond pointed pick is used, but fot clayey soils the point is considerably flattened. The mattock for cutting tree roots is a species of pick, as also the beater for packing railway sleepers or such like. The tramp pick, used in some parts of the country, has a cross handle, being worked with both hands with a small spur for the foot. It is useful for bringing down the sides of a cutting in larger masses than the ordinary pick, especially when joints or cracks appear on the surface of the ground. The best pick handles are of young ash split in preference to sawing, and the points should have about 2½ lb. each of the best steel. The weight of the common earth pick is from 10 lbs. to 12 lbs. exclusive of the handle.

A smith who is well acquainted with tempering may keep a large gang of men employed, whereas if this be not properly understood three men may be required to do the same work with less satisfaction.

Quarry Tools.—For quarrying purposes, picks of a shorter and heavier construction are necessary, varying considerably in weight according to the hardness of the stone. In the working of granite these reach their limit, some being 36 lbs. in weight. To render the subject more explicit we have chosen one quarry as a type, and when we have described all the tools used we shall mention some of the modifications which the quarrying of different rocks render necessary. The quarry we have chosen is situated near Craigmillar Castle on the south side of Edinburgh, the stones from which are now being used in the construction of the new dock works at Leith. The rock is a hard compact freestone which lies in nearly horizontal beds from 1 ft. to 6 ft. in thickness. Heavy beds of conglomerate overlie the better qnalities of rock, and the whole is so hard that it requires to be blasted with gunpowder or other explosive substance. The drills used are from 3 ft. to 9 ft. long and from 1 in. to 1½ in. in diameter, all of cast steel, having mouths from 1½ in. to 2⅜ in. wide, and the holes bored vary from one ft. to 8 ft. in depth. The boring hammers are about 9 in. long and 9 lb. in weight, with handles about 3 ft. long.

The wedges used for breaking up the squared or block stone from their beds are from 5 in. to 15 in. long and from 3 lbs. to 12 lbs. in weight, smaller wedges from 2 in. to 3 in. long being used for cutting up into separate stones when required. The hammers used for driving these wedges are, for the heavier wedges, 18 in. long and 2¼ in. to 2½ in. square across the eye, weighing from 17 to 20 lbs.

The picks used are of two kinds, called for distinction "rock picks" and "scabbling picks," the former slip eyed, weighing 14 lbs., the latter fast eyed, weighing 10½ lbs. These vary from 18 in. to 22 in. in total length, 2¾ in. to 2¼ in. square in centre, tapering to 1¼ in. and 1 in. square towards the ends, and being diamond pointed. The eyes are 2⅝ in. × 1⅝ in. and 2 in. × 1¼ in. with handles 30 in. and 24 in. respectively.

To take off part of a very rough bed in blocking ashlar, pinchers are used. These are about 13 in. long by 2½ in. square in center, with similar eyes to those above described, and sharped to one side like a carpenter,' chisel. This is held on to the stone by means of a short handle and struck with a 17 or 20 lb. hammer.

Besides these tools just described, square blocking hammers 13 in. long × 3½ in. × 2½ in., and 22½ lbs. in weight, are used for straightening the edge of the stone, and these in some cases are tapered on one side to 1½ in. square for driving the small wedges before referred to.

In quarries of softer material with more regular and uniform beds, where no blasting substance is required the stone can sometimes be cut out to any given dimensions with small wedges about 4 lbs. weight, holes for these being made with the ordinary quarry or rock picks. In others a double-ended drill about 6 ft. long and having a ball in the centre about 6 lbs. weight, is used instead of a quarry pick, and a row of workmen stationed along the upper bed of the stone alternately raise and drop these on the same spot until holes from 1 in. to 3 in. deep are made along the line marked off to be cut. Into these, wedges are driven to separate the stone from the rest of the bed. The beds in many sandstons quarries require little dressing, and the picks for scabbling are in general much lighter than those described, as the rock in the quarry we have named is among the hardest of its kind.

The ordinary shovel in use on contractor's work has the form of a shield about 14 in. × 13 in. with a handle of ash 2 ft. 6 in. long, and it requires about fifteen shovelfuls to fill an ordinary wheelbarrow, of which there are about twelve to the cubic yard. If 4d. per cubic yard be taken as a good price for filling earth, we have from 45 to 50 shovels filled for every 1d. It requires a good deal of shovelling for a laborer to make a competence if he is paid by measurement at this rate.

The spade on contractor's work is almost exclusively used for cutting clay. It has a square mouth and is 13 in. long by 6 in. or 7 in. broad in the blade.

The wheelbarrow, we have reason to believe, is not a modern invention, as the use of wheels has been known to the Egyptians from the earliest ages. In its present form, however, we have no reason to believe that it has

been used for centuries. Where slave labor could be employed, or when free laborers were cheap and abundant, no necessity existed for economising these to the utmost, and we incline to believe that this important little vehicle has been reserved principally for these days of excessive competition among contractors when low prices for heavy work have been pushed to their utmost extreme. A simpler or less expensive method of removing earth for a short distance it is difficult to imagine, the conditions being that it should be proportionate in length between the bearings and the axle (about 4 ft.), of proper width between the shafts (about 2 ft.), that the wheel should not be less than, nor much exceed a certain diameter (say 18 in.), and that the centre of gravity should be as low as possible. Above all the greatest possible strength should be attained with the least possible weight, which should not exceed 90 lbs. to 100 lbs. The covering varies in thickness from ⅝ in. to 1 in., according to the nature of the material requiring to be removed.

Special Plant.—Having described some of what may be denominated "hand implements," we come now to speak of "special plant." The following four items are from the Aberdare Water Works Extension:

1. Centre for building the aqueduct.
2. Pug mill for mixing the clay.
3. Plant required for the tunnel.
4. Wooden pump specially constructed for drying filtered water well.

Sketch of the Aqueduct Centre.—First, aqueduct centre. The aqueduct was about 20 miles long, oval in form, 3 ft. 9 in. high, by 3 ft. 3 in. wide, having one ring of bricks 6 in. thick all round. It was of the greatest consequence where such a length of brickwork had to be excavated with only a single brick ring that the centre should be easily set and struck, as a very short time was required for throwing the arch and backing it up with clay puddle on the haunches and earth on the top. For this purpose centres were constructed 10 ft. to 15 ft. long, with three or four ribs each, having a sole plate, with bearers under each rib. The upper part or arch was hinged at the crown, and connected with the sole by a malleable iron plate 1½ in. thick, having a shaft running the whole length of the centre fixed to the sole plate, and a pin 1 in. in diameter fastened to the lower bearer of the movable rib. To the square end of the shaft two levers were attached, by which the centre, on the removal of the wedges which kept the ribs to their proper width, was detached from the brickwork, and drawn forward another length by a hook attached to the front of the sole plate.

Pug Mill.—Second, pug mill for working the clay. As pure clay for the reservoirs was not found in the district, but required to be brought from a distance at considerable expense, it was used very economically and mixed with clay of an inferior quality, and so thoroughly cut and watered that a reservoir formed of a bank of vegetable soil and gravel with a wall of puddled clay in the centre 18 in. thick, and having a pressure of 16 ft. of water, has shown no sign of leakage. With an engine of 10 horse power as much could be mixed as two men could fill into a wheelbarrow. Many different forms of clay mill are in use and a description of their peculiarities might be interesting, but as our space will not permit we must refer you to the tracing, from which the details may be easily gathered. We may, however, remark that the employment of a pug mill in some form for the proper mixing of clay puddle, would at the same time make better work with far less material, and effect a large saving in the expense of reservoir embankments.

Third. A special feature of the water works named is a tunnel about 790 yards long, through a very hard rock of the nature of whinstone, but having very few joints or beds and requiring immense labour to bore through. It was worked from both ends and two shafts sunk on either side of the summit. These were each about 100 ft. deep. A winding engine or hoist was erected at each shaft for the purpose of lifting the water and rubbish, and a fan attached for forcing pure air into the headings. The hoisting engines were of the ordinary construction with two 6-in. cylinders, one working a hemp, the other a wire rope for hoisting materials out of the shafts. Experience taught the comparative safety of the iron wire in comparison with the hemp rope for this purpose, as on one occasion the latter gave way without warning, precipitating the empty hutch to the bottom of the shaft. No single thread of the rope was observed to have given way previously, whereas the iron wire rope, on the contrary, had some of its outer wires broken long before it was unfit for use.

Common fans were used for forcing pure air into the headings, the air being conducted through wooden spouts from 4 in. to. 5 in. square inside, in lengths of 10 ft. to 12 ft., having one end tapered, the other bell-mouthed, and the joints made with a little rope-yarn and clay. As gun-cotton principally was used in the tunnel the smoke was not so dense as with gunpowder, but the effect in a confined place is much more injurious and generally gives a stranger a severe headache.

The tunnel was straight. To set off the centre line and provide an easy method of testing its accuracy, a brick pillar was built on the summit and a plate with a screw for fastening a theodolite on it set on the top. From this station a good view of both shafts could be got, and two weights suspended on fine brass wires were hung down into the tunnel and steadied at the bottom in two buckets of water. From irregularities in the sides of the shafts these could be hung at the distance of 4 ft. apart only. The line was produced on both sides from these wires and holes bored in the roof, in which plugs of wood were driven to which cords with weights attached were fastened, so that the viewers could at any time ascertain the centre of the tunnel at the face of the heading. When the two faces met the tunnel was found to be perfectly straight.

Model of Pump.—About the time of the opening of these works a stone had accidently got below the large sluice in the filtered water well. To empty the well for the removal of the sluice a drain pump 6 in. in diameter, driven by a steam engine, was tried but found insufficient. A wooden pump, was then specially constructed for the purpose. It consists of an outer casing 15 in. square inside, with a wooden box 9 in. square and 1½ in. thick for a piston. A valve was placed as usual on both the outer casing and the piston. The displacement by the piston on the descending stroke caused the water to ascend through the valve in the piston and discharge through the opening on the side of the piston and pump casing, while in ascending the contents of the piston are discharged thaough the same apertures. The valves are of the most simple construction, in fact, any of the ordinary forms of valve may be used. The pump was worked by six men, the lift being 5 ft., and it was calculated to discharge about 30 cubic feet per minute, or upwards of 11,000 gallons per hour. By means of this pump the well was dried to within 3 in. of the botom without difficulty, which allowed the stone to be removed. This pump is well adapted for low lifts, but we are not sure that it would be suitable for more than 15 ft., although if it could be worked up to 20 ft. or 25 ft. it would be very valuable for emptying ships' holds, or similar purposes. It would certainly be worth a trial.

While on the subject of water works plant it may not be out of place to make a few remarks on shoring and strutting deep cuttings, also on scaffolding. No matter in connexion with contractors' work demands greater prudence and judgment than to know how to put in shores in dangerous cuttings, and very often great risks are run in the attempt to save a little timber and labor, when if the work is finished without accident all ends well, but if on the contrary, as is often the case, the sides of the cutting give way, far more money is spent than would have paid for the proper timbering of the work. It is impossible to lay down any definite rule on the subject from the variety of circumstances which present themselves, but it is too often the case that this part of the work is left to the foreman of a gang. and being done according to no rule is often very insecure.

For narrow excavations, such as sewers, aqueducts, &c., in deep cuttings (say over 15 ft.) in ground which is very loose, wet or apt to slip from any other cause, it would be a great saving to have regular frames, say, from 12 ft. to 15 ft. long and about 6 ft. deep, the one made to go easily inside the other, and being slightly tapered, the excavation could be conducted with perfect safety, while on the top of each frame a platform could be erected for throwing up the excavations in successive lifts to the surface of the ground. The cross struts being made movable the aqueduct could be built, or the pipes laid, and the sides pulled out singly as the cutting is again filled in. Or, again, light H-iron posts in lengths of 6 ft., leaving the web partly open to allow of planks being passed through and the inner flange grooved on the face so that the second post might slip into, and be held fast by the first, the third by the second, and so on, as many as may be required. The planks could then be slipped down as the work proceeds, and being laid close and uniform, the pressure of the bank would be equally distributed along the whole, cross struts being put in where required. Many similar expedients could be resorted to, but the different circumstances of each would require to be specially considered as they presented themselves. For instance, a railway cutting in side-lying ground with very limited space on the upper side side requiring to be supported by a retaining wall presents a case requiring great care, especially if valuable property be near the upper side of the cutting, and requires to be supported. The work may require to be executed in short lengths, or the whole wall built in the inside of a wooden framework strutted off the ground on the lower side or sheet piling behind the proposed wall may have to be driven before the ground is broken. In any case the contractor will be cheaper in the end to expend a little more than he considers practically safe, as any alarm caused even by the most nervous individual during the work may, however groundless, cost the contractor far more than very substantial shoring, not to mention the trouble and delay consequent on such interruptions.

(TO BE CONTINUED.)

Canal-Lock Lift.

The device for the Potomac Lock and Dock Company for lowering canal boats from the canal to the river at a point about a mile and a half above the Aqueduct Bridge, Georgetown, was yesterday morning subject to the test of experiment and gave every indication of successful operation. This is an engineering enterprise of considerable interest to the trade of Georgetown and to the carrying business of the Chesapeake and Ohio Canal, and is the only one in existence in the United States.

The inadequacy of wharfage facilities at Georgetown has long been the occasion of great difficulty, inconvenience, and delay alike to merchants and transporters, canal boats being often detained as much as a week before getting an opportunity to unload, while vessels in the river are also subjected to considerable delays in waiting for their cargo. The new improvement above referred to is intended to remedy this difficulty by letting the canal boats down into the river.

At the point above mentioned (a mile and a half above Aqueduct Bridge) a dock has been constructed on the right of the canal into which boats intended to be lowered into the river are turned aside. At the lower end of this dock is a gate, through which the boats are to be passed into an immense tank, technically known as a "caisson," which has a water-tight gate at each end. The upper end of this tank forms a water-tight joint with the lower end of the dock, and by opening the gates a boat is readily transferred from the dock to the tank, after which the gates are closed, and the tank or "caisson," with a canal boat afloat in it, is prepared to transport its burden to the river. The tank is mounted on trucks in such a manner as to keep it level, and is let down to the river by means of a double-track railroad, which runs out into the water far enough to sink the tank entirely below its surface, in which position the boat is floated easily into the river. This tank is let down and drawn up by means of a turbine wheel of sixty-eight horse power, which, however, would be wholly inadequate for the purpose but for the fact that the weight of the tank is balanced by that of two great cars loaded with rocks, which move on side tracks, descending the inclined plane toward the river as the tank ascends from the river toward the dock, and *vice versa*. The tank is kept full of water in ascending, and, as a canal boat on entering it, displaces exactly its own weight of water, the weight of the tank and its contents remains invariable, and the balance between it and the cars on the side tracks is thus constantly maintained. The traction is applied by means of immense wire cables, which pass over iron wheels of great strength, the turbine wheel merely furnishing power enough to overcome inertia and friction.

The trial made recently, under the supervision of Mr. Hutton, chief engineer of the Chesapeake and Ohio Canal, gave every indication of successful working.—*Washington Chronicle.*

SATURDAY, JULY 8th, 1876.

GEO. H. FROST, - Editor and Publisher.

153 Washington Street, Rooms 51 & 52, Chicago, Illinois.

CONTENTS:

Editorial Notes	217
Improved Sewerage of Boston	217
The Late Mr. John Brown	217
Annual Meeting of the American Inst. of Mining Engineers	218
Compound Cylinder Locomotives	219
Railroad News	219
Publications Received	219
First Railroad in China	219
Point Bridge Across the Monongahela River at Pittsburg, Pa.,	220
The Fullerton Avenue Conduit	220
Notes	222
The Fastest Cable Telegraphy	222
What is Bad Water	222
Contractors' Intelligence	223
Contractor's Plant	223
River Protection at Plattsmouth, Neb.	224

EDITORIAL NOTICE

An absence from the city for two weeks, of the editor of this journal, and the interruption occasioned by the Fourth of July holiday, happening just at the time of adding to our pages, have interfered somewhat with the regular issue of the NEWS.

We hope our readers will excuse the delays of these two weeks, and we expect hereafter, that our paper will be issued as promptly as heretofore.

THIS time it is a Frenchman, M. Manier. He must be a very grave joker. He has published a pamphlet entitled, "Grand Canal du Midi," and the papers, big and little, scientific and otherwise, have copied it without a thought but that another De Lesseps had conceived a project of unheard of benefit and grandeur to the human race. The Pall Mall *Gazette* of June 13, makes some estimates on this scheme based on the data given by M. Manier, to whom, in the grandeur of his imaginings the element of cost never seemed to occur.

The bottom of the canal is to be 32 ft. below sea level the whole distance. It is divided into five sections: the 1st from Blaye to La Reole, a distance of 80 kilometres, will have an average cut of 15 metres and a width of 180 metres; 2d, from La Reole to Toulouse, 175 kilometres, with average cut of 78.18 metres and width of 100 metres; 3d, from Toulouse to Carcassone, 90 kilometres with mean depth of 141.4 metres and width of 80 metres; 4th, from Carcassone to Narbonne, 60 kilometres, with mean depth of 62 metres and width of 100 metres, and 5th, from Narbonne to the sea, 10 kilometres with mean depth of 12 metres and width of 180 metres.

The deepest cutting is at the Narouse basin. 188.3 metres or about 650 ft.

The Pall Mall *Gazette* estimates the minimum cost at about £1,500,000,000 and that it would take 200,000 men a little over 91 years to execute it. At the time of completion interest on capital, etc., would bring the cost up to near £5,000,000,000.

For magnificent disregard of financial considerations in engineering design we believe America will have to yield the "palm" to this Frenchmen.

MR. HENRY C. SPALDING, an American engineer, has announced a project for restoring the ancient water level of the Caspian Sea, which has received much attention in European circles, and which seems to be regarded as entirely feasible. He proposes to commence the work at some point in the Caspian basin where the surface is 50 ft. below the Black Sea, and extend a level channel 500 ft. in width, westward, until 35 ft. fall is obtained; from that point the channel will be continued with a width of 150 ft., and a depth of 15 ft. below the Black Sea, shoaling to 10 ft. at its shore. Water will flow through this channel at the rate of 8 miles per hour, and with proper direction will excavate a channel of the full size of the larger section, which shall be navigable, and fill the entire Caspian basin in about 40 years. By diverting the Don into the Volga river, which can be done at moderate expense, the time of filling would be reduced to 25 years.

The Caspian sea will then be much larger than now, more evaporative surface will be exposed, and a new climate and a new fertility will again make the desert to blossom as the rose.

FROM time to time there have been broached various schemes for flooding a part of Sahara desert, a large portion of which, it is asserted lies below the level of the sea. One of these sinks or depressions lies in Algeria, a province of France, back of the Atlas mountains, and is marked by a series of marshy lakes. The lowest and easiest connexion with the sea is through Tunis, which it is asserted can be opened at small expense. Another connexion is proposed through Algeria itself, which, owing to deep rock cuts, would be quite expensive. If this work was completed it would make a sea of considerable extent back of the Atlas mountains, and do much to ameliorate the climate and render fertile a large tract of country on the borders of the desert, besides bringing a seaport 300 or 400 miles nearer Soudan on the great French caravan route. The dangers of this route would also be much mitigated. The scheme has been closely investigated by French engineers, but we believed abandoned for the present on account of non-satisfactory arrangements with Tunis.

MR. MCKENZIE, with a party of ten, leaves London at the beginning of this month for Western Africa, to explore a route for a canal, to connect the Atlantic with the great sink which extends from the valley of the Belle to Timbuctoo, covering an area of some 120,000 square miles. He is very confident that a canal eight or ten miles in length will suffice to turn the waters from the ocean into the basin. Should he succeed, there can be no doubt of the immense benefit that will result to commerce: in the trade and developement of a large country hitherto comparatively shut out from civilization.

LIEUT. CAMERON said recently in an address before the Royal Colonial Society, that Africa, between 4° and 14° south, was a country of enormous richness and comparatively healthy, abounding in mines of gold, silver and coal. The river Congo is believed to be navigable for river steamers many hundred miles, and can be joined with the Zambesi in many places by a canal twenty miles in length.

COLOMBIA, S. A., having stopped fighting for awhile has turned her attention to the Panama Canal project which commander Selfridge of the U. S. N. has spent so much time in investigating. They think they have found a lower profile than any yet found, and one entirely feasible for a through cut. Costa Rica is pushing her inter-oceanic railroad to an early completion.

GEN. W. SOOY SMITH held a conference last Friday night with a committee of the Common Council of Detroit, in regard to the tunnel project, with the result that his proposition was favorably received, and that the city will endeavor to interest the railways in the scheme. He expressed his entire willingness to submit his plans to any committee of experts the city may choose. The Gen. proposes to employ English capital in the building of the tunnel. The bill for bridging the river, at present in committee, is not likely to receive the sanction of Congress.

IMPROVED SEWERAGE OF BOSTON.

In No. 8, of the NEWS, we published the plan of the Sewerage Commissioners of the city of Boston. The matter is now before the City Council; the majority of the joint special committee on improved sewerage have reported in favor of this plan, and the matter is now referred to the Committee on Finance. An order also accompanies, appropriating $40,000 for making surveys and plans and procuring estimates. The committee says in its report, that the only expenditure required this year, if the commmissioners report is adopted, will be the above sum for sewerage, and they also think that no greater sum than $1,000,000 will be called for per annum, as the work cannot be judiciously pushed forward faster.

The sewer to Moon Island and its connections with the present system are contemplated as the portions to be built at present.

AN ESTIMATE OF THE COST.

of constructing the works required for a new sewer beginning at Tremont street and discharging its sewage at Moon Island, is as follows:

Main sewer from Tremont street to pumping station at Savin Hill	$544,610
Engine and pumping-station	300,000
Main sewer from pumping station to Moon Island, ineluding siphon	1,020,000
Reservoir	360,000
Branch sewers in Boston proper and South Boston	$605,000
Land damages	125,000
	$2,954,610
Add ten per cent for superintendence and contingencies	295,460
	$3,250,070
Rebuilding and connecting present sewers	300,000
Total	$3,550,070

The engineer states that in the absence of sufficient data from which to judge of the amount of piling and other work necessary to secure a solid foundation, he has made a liberal allowance for such work, and it is quite probable that his estimate for that item is too high.

This cost is to be distributed over several years, and it is recommended that one-half of the yearly amount be raised by taxation and the other half by a loan. It is thought that the burden will thus be found very light, while the expense is incurred for no luxury, but for a prime necessity—good health. We have before remarked on, and called attention to the necessities of the case. The reports of the Board of Health show that the cause of many diseases are for the most part due to defective drainage. The ravages of diphtheria have been very extended among young children.

We quote from the *Boston Herald*, to which we are indebted for the above data, some facts which show the necessities of the case, necessities which the present heated term renders if possible, more urgent.

"An intelligent person may see in a half-day devoted to an examination of the city's water-front that in the event of an epidemic of the cholera, the disease will find potent allies in every one of the scores of sewer outlets along our wharves. Sewage filth lies rotting on the Charles River flats, it turns the water in our docks to poison, and fills the air at times with intolerable stenches. It is a fact that between the piles of many of the wharves, where of course dredging is impossible, the sewage filth is deposited for from four to six feet deep. In such places the deposit is of a slimy nature, offensive to both sight and smell. It is true that New York is similarly drained by sewers emptying along her water front; but the powerful currents of the East and North rivers sweep the filth, which would otherwise remain, out to the ocean. On the the 18th ult, a case which will serve as an example of many similar ones coming to the knowledge of the Board of Health, occured at the Home for Aged Women at the foot of Revere street. During the day, which was a hot one, the tide in the Charles ebbed low, leaving the sewage filth on the flats exposed to the sun. Soon the poisonous gases evolved made their presence only too apparent to the sense of smell. The atmosphere of the entire neighborhood was made almost unbearable. The effect of this air-poisoning was seen in the prostration, with vomiting and diarrhœa, of eleven of the inmates of the Home. Such facts as these, and there are plenty of them, are more convincing proofs of the need of improved sewerage than anything else that can be ad duced."

THE LATE MR. JOHN BROWN.

Probably no man has been so identified with the public works of Canada as the contractor, John Brown. He was pre-eminently a "self-made man."

He built a large portion of the Welland Canal, built many lighthouses for the government, constructed much of the Great Western Railway, deepened Montreal harbor and dredged the ship canal through Lake St Peter, built the Welland Railway, improved the harbors at Saginaw Bay, Southampton, Goderich, Kincardine and also the entrance of the river Thames; and the present St. Clair Flats Canal.

He was also interested with Alex. McDonald in other schemes of public improvement, probably the most important of which, to the United States, was the Caughnawaga Canal, which was to connect the St. Lawrence above Lachine Rapids with the outlet of Lake Champlain, thus enabling the largest lake vessels to enter that lake, which scheme was considered favorably in the Senate Report of two years since.

The Franklin Institute of the State of Pennsylvania is celebrating the semi-centennial year of its existence, which comes most opportunely in the present year, and enables that very valuable and useful society to enhance the attractions of the Centennial Exposition in Philadelphia. The society have extended invitations to engineering societies and to all such persons and associations as are interested in the mechanic arts, to visit its museum, and enjoy the privileges of its rooms,

while in Philadelphia, and more recently it has opened a reception room in Machinery Hall for the use of its members and vistors from abroad. To this last courtesy we call the attention of our readers.

The following objects of great historical interest have been placed in the room:

1st. *Franklin's Electorical Machine.*—This instrument is doubtless the one used by the great philosopher in making his wonderful experiments in the science of electricity. Presented to the Institute by Dr. John R. Coxe.

2d. *Oliver Evans' Steam Locomotive Engine.*—This interesting model is among the earliest known, having been built about 1804.

3d. *Oliver Evans' High Pressure Steam Engine.*—This is the model of an engine built by O. Evans, about 1804, and is described in Galloway's work on the Steam Engine, page 101.—London, 1827.

4th. *Working Model of a Steam Engine* built by M. W. Baldwin, and presented by him to the Institute, about 1832.

J. B. KNIGHT, Secretary,
J. E. MITCHELL, Chairman.

Annual Meeting of the American Institute of Mining Engineers.

(Special Correspondence of Engineering News.)

PHILADELPHIA, June 23d.

At 10 A. M. the Institute was called to order by the retiring president Mr. A. L. Holley.

Prof. Y. C. Broadhead of the School of Mines, at Rolla, Mo., presented an interesting paper on the nature and extent of the "Lead Mines of Missouri."

Mr. Oliver Evans Woods of Philadelphia read three original documents of his grand-father, Oliver Evans, setting forth his claims to the discovery of the "Hot Blast," the use of green or uncoked coal in smelting Iron, and the use of the "Steam Jet," to produce a draft and maintain combustion.

Dr. Hermann Wedding of the German Commission to the Exposition, read an original paper entitled, "An International Nomenclature for Iron," to be adopted by the leading Iron producing nations, England, Sweden; Germany, and the United States. He bases his system on the science of manufacture.

Dr. Eggleston of Columbia College endorsed Dr. Weddings' system, and thought the present a favorable time to appoint a committee of experts to consider the subject.

Mr. Holley supported the idea in the main, but suggested a modification of the names.

Prof. Frazier thought that the characteristics of the iron itself should be used as a basis of classification rather than the process of manufacture.

Dr. Eggleston communicated some facts in regard to recent discoveries of Boron and some of its compounds in Lake Superior ore including a new mineral the Borate of Magnesia and Lime.

Dr. Newberry, State Geologist of Ohio presented a paper with maps and specimens, on the "Black Band Iron Ores of Ohio."

At the conclusion of this paper Dr. Eggleston moved the appointment of an International Committee on the Nomenclature of Iron and Steel. This motion was enthusiastically carried—Mr. Holley to be a member of the Committee.

Mr. W. Hunt of Troy, N. Y., read a paper on the "History of the Bessemer Process in the United States." This history covered a period of about ten years. After detailing the progress of the process in this country, he gave a high compliment to Mr. Holley, to whom is due the credit of designing nearly all our Bessemer works, and for the remarkable efficiency which they have developed in comparison with foreign works.

Mr. John D. Pearce added much to the statement of Mr. Hunt, claiming for J. Edgar Thompson and the Pennsylvania Railway Co. much credit for establishing the process on a firm basis. It was but an accident of business that deprived Mr. Thompson of the credit of first introducing the process.

At this point a recess was taken until the afternoon.

The first paper of the afternoon was by Mr. W. E. C. Coxe, Supt. of the Reading Railway Iron Works, on the "Manufacture of Iron Rails."

The paper detailed the processes of manufacture of the various grades of iron and steel rails, also interesting facts and statistics in regard to the life of rails and, its connexion with their quality. At this point the gentleman criticized Mr. Lothian Bell's paper on the "Theory of the Hot Blast," which aroused quite an animated discussion with Mr. Bell and Dr. Wedding.

Mr. L. A. Riley then read paper on "Geological Exploration with the Diamond Drill," in which he submitted many facts in regard to the performance of said drill, of much interest to those who contemplate the use of such drills.

Mr. J. Blodgett Britton presented a paper on "The Composition of Flue Deposits," which was of much interest.

Mr. Henry S. Munroe of Brooklyn, N. Y., gave an account of "The Coal Fields of Japan," illustrated by a large map. He stated that mineral resources of Japan had been overrated. There was very little hard coal, and not an over-stock of soft coal. The coal fields covered about 5000 square miles. The following table gives the product of all kinds of minerals in 1874.

Coal	436,800 tons (2000 lbs.)
Petroleum	275,825 gallons.
Iron	5000 tons, (2,240 lbs.)
Copper	3300 tons (2000 lbs.)
Lead	207 tons (2000 lbs)
Silver	312,000 ozs. Troy.
Gold	32,000 ozs. Troy
Tin	8.4 tons. (2,000 lbs.

The only promising coal mining is done by Englishmen. Seams six tenths of a foot in thickness are worked.

The meeeting then adjourned until evening.

At the evening session, Mr. Julien Deby of Belgium, presented a paper on the "Chaudron Method of Sinking and Tubing Shafts." The discussion of this paper was most interesting, and will be given at a future day, dealing with a description of the complete models now in the Exposition.

The paper on "Spelter Manufacture," by F. S. Clerc of Bethlehem, Pa., described briefly an invention of the author, for reducing zinc ores, which is a modification of the blast furnace. The paper was considered of great value,

Mr. O. J. Henrich gave an account of an "Explosion of Fire Damp," in the Midlothian Mine, Va., which elicited much interest.

Prof. Persifer Frazier, assistant State Geologist of Pennsylvania, declined to read his paper on "A Study of the Specular and Magnetic Iron Ores of New Red Sandstone of York Co., Pa." on account of the lateness of the hour. The meeting then adjourned.

SATURDAY June 24th.

At 8:30 A. M., a train of seven cars left the Depot at Third and Callowhill streets, by the Phil. and Reading R. R. for Phœnixville and Bethlehem.

Many foreign Engineers were in the company. Much credit is due the Committee of arrangements for the comfort and enjoyment of the trip.

On arriving at Phœnixville, we were escorted through the Phœnix Iron Co's works by the president of the Co., Mr. Reeves, and the Supt. Mr. Griffin. The Company have a very complete plant for all kinds of bridge and iron work, and for all processes of iron manufacture, from the ore up. There are also many special and interesting features peculiar to these works, which lack of space forbids mention. These works are among the most extensive in the country. At present they are building a bridge for the Phil'a. Wilmington & Baltimore R. R. at Havre de Grace.

We also visited the Copper Works at this place. The ores are treated by the Hunt and Douglass process in the best way. All the plant is very handy and complete.

At 12 M. the party left for Bethlehem by the Perkiomen Branch, opened last October, to Allentown and then by Lehigh Valley line to the Bethlehem Iron Co., Works.

The Bessemer plant is very complete in every particular, and of the usual type of the Bessemer works in this country, as designed by Mr. Holley, The time from the ore to the completed rail is about 16 hours.

Owing to the time so interestingly spent at the Bessemer works, no opportunity was given to examine the zinc interests at this place At 4 P. M., the company returned to Phil. after a very profitable and pleasureable day.

MONDAY, June 26th.

At 10 A. M. a business meeting was held at the Franklin Institute Hall. During the year there had been 214 admissions; the present members numbered 612. After the business meeting, the reading of papers and discussion thereon were resumed.

J. D. Pearce, gave a statement of "The Early Iron Trade of this Country," tracing the history from the first diseovery up to the present time.

Prof. Persifer Frazier read his paper on "The Iron Ores of the New Red Sandstone of York Co., Pa.," which was deferred at a former meeting.

Mr. J. H. Bramwell, Supt. of Quinnemont Furnace. Va., gave his valuable experience in a paper entitled, "The Partial Renewal of a Blast Furnace Crucible when in operation."

Mr. C. H, Vannier explained the "Method of Roasting Superfluous Iron Ores in New Jersey."

Mr. J. Blodgett Britton, of the Iron Masters' Laboratory, read a paper on "The Occurrence of Water in Coal and the Method of Determining it."

The meeting then took a recess until 2 P. M.

On re-assembling, C. R. Boyd Jr., of Wytheville, Va., gave a description of "The Minerals of S. W. Virginia."

Mr. Coxe, Mr. Weeks and Mr. Deby of Belgium fell into a discussion on the burning of coal dust, and also in regard to the smelting of iron with gas. The latter had not yet succeeded.

Mr. Drinker presented some interesting facts in regard to the history, progress and method of working the Sutro Tunnel.

The names of the "International Committee on The Nomenclature of Iron," was then announced as: Dr. Ackerman of London, I. Lothian Bell of England, Dr. Gruner of France, Mr. Tanner of Austria, Dr. Wedding of Germany, Prof. Eggleston of Columbia School of Mines N. Y., and A. L. Holley of New York.

A recess was then taken until evening.

Prof. Adolph Henri presented a paper on 'The Manufacture of Forged Iron Car Wheels'

Mr. H. S. Munroe of Brooklyn, presented a paper on the "Metalliferous Deposits of Japan."

Prof. Persifer Frazier, gave illustrations on a screen of a Microscopical Study of aqueous rocks.

Resolutions of thanks were given to the retiring President Mr. Alexander L. Holley, to which he responded finely, and the Institute of Mining Engineers adjourned to the third Thursday in October. This ended the session, with the exception of the final excursion tomorrow.

TUESDAY, June 28th.

To-day is the grand *finale* of the Convention, an excursion to the Coal and Iron Region of Pennsylvania, given by the President of the Phil'a. and Reading R. R. Company.

By 8.30, A. M., a company numbering about 250 gentlemen, members of the American Institute of Mining Engineers, and invited guests, had taken their seats in the excursion train, which steamed out from the Depot at 3d and Callowhill streets. Among the distinguished gentlemen in the party we noted: Sir Redmond Barry, Centennial Commissioner from the British Colony of Victoria and Chief Justice of that province; I. Lowthian Bell, M. P. England, Judge in the Mining and Metallurgical Section of the Exhibition; Mons. Arbel and Henri from France; Jean Beco, of the Belgian Commission; E. Zelenkoff, S. S. Serebenikoff, Nicholas Jossa, and Mr. Gadolin, members of the Russian Commission; Baron Charles De Engerth, of Austria; J. C. Icely, Switzerland; J. H. Sebenius, Sweden; Prof. Richard Akerman, of the Swedish Royal School of Technology, and a member of the Jury of Awards in Mining and Metallurgy; Daniel de Cartazar, Special Commissioner of Spain; J. Laidlaw, of Toronto, Canada, Centennial Commissioner; Dr. Wedding, Prof. Hoernecke, and Bergrath Broja, Special Commissioners from Germany to investigate the mineral resources of this country; Ernest Albans, of Germany, Judge in the Mining Section; Prof. Raymond, United States Commissioner of Mining; A. L. Holley, ex-president American Institute of Mining Engineers, Eckley B Coxe of Luzerne county; W. E. C. Cox, Manager Philadelphia and Reading Rolling Mills; J. W. Jones. Vice-President, and William Lorenz, Chief Engineer, Reading Railroad Company.

The route lay though the beautiful Schuylkill valley, famous for its fine farms, and the magnitude of its manufacturing interests. At Reading we stopped to examine the various industries at this point. The loco-

motive shops were first visited, where can be seen locomotives in all stages of construction. Supt. Wootten's method of burning coal dirt appears to be a complete success. The Car shops were next visited, and struck the visitors not only by their extent, but for the wonderful adaptability of the machinery for the work in hand.

The rolling mills of the company are finely situated, and cool. Here we saw Mr. Coxe's method of rolling rails, described in his paper before the Institute. All the works of the R. R. Co. at this point are more than usually well adapted to the work in hand.

After lunch, we rode through more fine country by Lebanon to the Cornwall Ore Banks These banks are great mountains of ore, and have been worked since 1728. They have been mined down 300 ft., but the bottom of the deposit has not been reached. They are perfectly dry. The ore is shoveled directly into the cars which run down to the blast furnace in the valley below by gravity alone. The cost of mining is but 18 cts. per ton.

We left here by way of Pine Grove and Tremont for Brookside Colliery, through a rugged and beautiful mountain country, over heavy grades and around sharp curves. Brookside lies in Williams Valley; coal out-crops on either side and a railroad runs up either side to take it out. Williams Valley is unequaled in the extent of its coal interests and beauty of its natural scenery.

The next objective point was Pottsville, by way of Tremont and Schuylkill Haven. Here a dinner was given by Franklin B. Gowen, president of the Reading R. R. After a most genial time and excellent speeches, in which Dr. R. W. Raymond of N. Y. delivered a graceful address to the foreign visitors, the company broke up for the night.

WEDNESDAY June 27th.

At 7 A. M. the train left Pottsville to visit the mammoth coal vein near by, which is 40 ft. thick. The shaft visited is the deepest in the United States, going down some 1600 ft.

We returned by Pottsville, passed by Mount Carbon, for the Mahanoy Plane in the upper mountain region, by way of Port Carbon and St. Clair. This incline comes up a vertical distance of 375 ft., from what is called the second Coal field in the valley below. There is also a tunnel and a second incline, Gordon Plane, used in connection with it. This work really needs to be seen to be appreciated in its engineering features.

Leaving this interesting point, we went on by Gerardville to Tunnel Colliery. Here we saw a master piece of colliery plant—monster coal breakers, screeners and sorters, in which manual labor is practically done away with. The dirt is dumped at the side of the mountain, to which it makes quite an addition.

After taking lunch at the residence of Mr. Riley C. E., of the Locust Mountain Coal Co. we returned by the Gordon Plane, finding our own train at the top, which had been sent round to meet us, After passing through the most enchanting mountain, scenery studded with collieries on every hand, the district where the Molly Maguires held everything in terror so long, we reached Schuylkill Haven and the main line of the Phil'a & Reading. for Philadelphia.

Every one was delighted with the trip, and full of thanks to Pres. Gowan. Thus ended probably the most noted and interesting session of the Institute of Mining Engineers.

Compound Cylinder Locomotives.

A compound cylinder locomotive is at trial on a French railway. It is the first of a set of similar engines made for the Bayonne-Biarritz Railway Company, by M. M. Schneider & Co., Creusot, on the improved comdound principle patented by a Swiss engineer, Mr. A. Mallet. These engines have only two cylinders, the small one of 8½ in. and the large one 16 in. in diameter; stroke 17⅜ in.; normal gauge; boiler pressure 150 lbs.; weight in working order about 20 tons. In the ordinary, circumstances the steam is admitted only in the small cylinder and expands in the other; but when starting or when a much larger amount of power is required, as on a steep gradient, each cylinder works with a separate admission and exhaust. Besides the saving of fuel expected the capital object is the reduction of heating surface in the above mentioned engine that surface being only 516 square feet.—*Engineering*.

Railroad News.

A narrow-gauge railroad is proposed up the valley of the Westfield river, from Huntington to West Chesterfield, Mass., twenty-five miles, to cost from $300,000 to $400000.

Operations were begun at St. George, Mew Brunswick on the 8th ult., upon the Great Southern Railway, and the first sod was turned in the presence of the president, directors, contractors and a number of the company. A salute was fired from Fort Douglas. Between 30 and 40 miles of the road have been sub-let and the work has begun on a portoin of the line.

The longest bridge in the world is the Chenab railroad bridge in the British East Indies, which was completed last December, having been in course of construction four years. The bridge consists of 64 spans, of 132 feet each, making the total length 9,300 feet, or more thah one and three-fourth miles. The masonry is all of brick, and is five million feet in quantity. The girders weigh 9,000 tons.

The Pittsburg Locomotive Works have put 100 men to work on the big links for the new Point Bridge. The delivery of the main links to the southern abutment was commenced last week. About five tons are hauled at once, and there are 1,400 tons to go from the bridge. The approach to the northern end looms up loftily, and when the towers are finished they must make a prominent feature of the city from nearly every point of the compass.

The Ohio River at Pittsburgh is 600 feet above the gulf. The Mississippi river is 2,616 miles in length and is 1,670 feet above the level of the gulf at its utmost source; at St Paul it is 660 fet above the gulf level; at the head of Rock Island Rapids 505 feet; at St. Louis 407 feet; at Cairo 322 feet; at Memphis 221; at Natchez 69 feet; at New Orleans 15 feet; and at the head of the passes 2 feet 9 inches. Arkansas river rises 1,514 miles from its entrance into the Mississippi, and 10.000 feet above the gulf level; at Fort Smith it is 418 feet above; at Little Rock, 252 feet; and at its mouth 162 feet. The Missouri river rises 2,908 miles from its entrance into the Mississippi, and 6,800 feet above the gulf level; at Fort Benton it is 2,815 feet above; at Sioux City, 1,065feet; at St. Joe, 756 feet.

Publications Received.

From the Institution of Civil Engineers:

Abstracts of Papers in Foreign Transactions and Periodicals. Session of 1875—'76. Part 1st, London.

Holyhead New Harbour, by Harrison Hayter, M. Inst. C. E., London, 1876.

Carlingford Lough and Greenore. By James Barton, M. Inst. C. E.

On Estimating the Illuminating Power of Coal Gas. By William Sugg, Assoc. Inst. C. E.

On the Probable Errors of Levelling; with Rules for the Treatment of Accumulated Errors. By Wilfrid Airy, B. A., M. Inst. C. E.

The Lagoons on the South-east Coast of Ireland. By George Henry Kinahan, M. R. I. A.

The Ventilation and Working of Railway Tunnels. By Gabriel James Morrison, M. Inst. C. E.

Report on the Ventilation of the Hall of Representatives and the South Wing of the Capitol of the United States. By Robert Briggs, C. E., Philadelphia, 1876.

The Manufacture of Steel and the Mode of Working it. By D. Chernoff, Asst. Manager of the Abouchoff Cast Steel Works. St. Petersburg. Translated by W. Anderson, M. Inst. C. E., London, 1876.

Second Annual Report of the City Engineer of Somerville, Mass., for the yenr 1875. Boston, 1876.

The Nursery, for June. John L. Shorey, 38 Bromfield street. Boston, Mass.

Mineral Map and General Statistics of New South Wales, Australia. Sidney, Australia.

The First Railway in China.

Mr. John Dixon's Chinese railway enterprise seems to have before it a fair prospect of success. All difficulties have, we believe, been removed by orders from Pekin that no obstruction is to be given to the fair trial of the English railway, a result doubtless due to the influence of Prince Li Hung Chang, one of the most enlightened and energetic men among the high governing class of China. The *North China Daily News* says: "The works of the Woosung Railway, as the road approaches completion, have fairly aroused the curiosity of the Chinese of all classes. During the past week, but especially since Sunday, thay have each day flocked literally in thousands, not only from the settlements and native city, but also from the villages and native districts for miles around, along its whole length. The streams of visitors are incessant from morning till night, and hundreds of jinrikshas, wheelbarrows, and other vehicles, all occupied, throng the route to and fro. Yesterday afternoon (March 29), for instance, the road was almost impassible, so great was the crush. The visitors comprised men, women, and children (the latter in large numbers), and all seemed anxious to see and understand what the foreigners were doing. The great center of attraction was the little 'Pioneer,' now engaged in running trucks of pebble ballast for the purpose of filling in the interspaces of the sleepers; and wherever the engine came to a stop, it was instantly surrounded by dense crowds, who gazed at it with wonder, those nearest examining every part of its visible machinery with attention, and talking and gesticulating with an earnestness that must be seen to be believed; strongly reminding one of the excitement evinced by the country people, especially during the early days of railway construction in England. Preparatory to starting on its brief journeys, the 'Pioneer's' whistle was of course sounded, and it was amusing to witness the crowd hurrying off in all directions, amid shouts of laughter and other tokens of unmistakable delight and approval, to make way for it. It may credibly be asserted that such a sight has never been witnessed in China before; and it affords clear proof that, so far as the people are concerned, there would be no obstacle in the general adoption of this mode of transit throughout the empire."—*Engineering*.

Sanitary Drainage.

It is a fact now generally accepted among scientific men that disease in almost every instance is the effect of poison. In the comparatively rare cases of personal contagion, this poison consists of diseased elements directly transferred from one individual to another. In a vast majority of cases the poison is unconsciously taken in the air we breathe, the water we drink, or the food we eat. It may have come indirectly from a sick person, or it may be the decaying product of a substance previously harmless; its origin may be difficult to trace, and its action may be very subtle; it is usually gaseous or liquid, and it is almost always some form of decaying organic matter. To confine these poisons within limits where they cannot reach the human system; to convey them away in the most innocuous manner; and, finally to destroy them before they have had an opportunity to act, is the function of sanitary engineering, which may be regarded as one of the most advanced departments for the profession, and unfortunately one to which attention has been directed only for a comparatively short time. There is one thing in which our American civilization is more deficient than in this. The mechanical improvements which serve to cheapen manufacture, to facilitate transportation, and generally to aid commercial enterprises of all varieties, we have accepted and advanced, and nowhere has this progress been more marked than in the newer parts of country at the West. On the other hand, the same communities which have been so alert in watching for everything which promised to increase their wealh, have shown an almost absolute indifference to the conditions requisite to ensure their health. It is only in some of the oldest sections of our country that even moderate attention is paid to engineering. It is not pretended that the most perfect drainage and ventillation would entirely relieve the race of its invalids. Hereditary constitutional weakness, imprudent habits of life, and a multitude of accidental causes would remain; but it is safe to say, that epedemics and and the violent diseases which now destroy so large a part of our population before they have attained their prime, can be almost entirely prevented, and that the average death-rate can be reduced at least one-half. The picture of a community which allows one-half of its number to die through mere neglect of proper sanitary precautions, is truly appalling.

Point Bridge Across the Monongahela River at Pittsburg, Pa.

We present with this number of ENGINEERING NEWS a double page illustration of the Point Bridge, at Pittsburg, Pa., now in process of construction by the American Bridge Company of this city, from the designs of Mr. Edward Hemberle, one of the engineers of the company. Mr. Hemberle and his associate, Mr. Coolidge, have designed some of the finest and largest structures of this country, not the least among which is the one we present to our readers to-day.

Point Bridge is to accomplish what was years ago intended to be obtained by the *tripartite project*, viz: To connect the city of Allegheny with the Pittsburgh Point and the latter with the south shore of the Monongahela River by the shortest line possible.

Union Bridge, already built, connects Allegheny with the Point, and Point Bridge is to connect the Point with the south shore of the Monongahela River. Mr. Chas. Davis, City Engineer of Allegheny and Consulting Engineer of the Point Bridge Co., located the bridge, and his original specifications were made for a cable suspension bridge with a center span of 800 feet center to center of towers, and two trussed side spans 110 feet and 150 feet in the clear respectively. The height of floor above mid channel of river, 290 feet from south tower, was fixed at 83 feet above low water mark.

Bids for building the bridge were received in the spring of 1875, with the understanding that they might be for cable suspension according to specifications or for any other plan submitted.

Proposals were made by most of the prominent bridge builders of the country, based on various plans, viz: Roebling's cable suspension, braced arch, Ordish system, cantilever, old style chain suspension and stiffened chain suspension. The plan adopted was the stiffened chain suspension, designed by Mr. Edward Hemberle, Engineer of the American Bridge Co., to which company the contract for building the bridge was awarded. Its total cost will be $450,000.

The illustration shows the elevation, plan, and cross-section of the bridge, and the details of the towers. The center span is 800 feet center to center of towers, and the side spans are 145 feet each in the clear. The height of the towers above low water is 180 feet, and the deflection of the chain is 88 feet. The roadway is 20 feet wide with double tramways and one track for a narrow guage railway; outside of the roadway are sidewalks six feet wide each.

The piers and anchorages are founded upon timber platforms sunk to a gravel bed. The masonry is of best quality Baden sandstone.

The superstructure will be the first example of a stiffened chain suspension bridge of long span and will differ considerably from others in existence. The chain is designed as a catenary and will take up all the permanent load of the structure without bringing strains on the stiffening trusses. This object will be accomplished by erecting the bridge completely before connecting the ends of the straight top chords to the center joint. The tie-rods are provided with turn-buckles and will be so adjusted as to be strained under moving loads only. When the bridge is half loaded the top chords of the trusses on the loaded side will be in compression and of the unloaded side, in tension. The maximum strains for the different members of the trusses occur under different positions of the moving load.

There are lateral and vibration braces between the top chords and also, between the chains, proportioned to take up the strains from wind pressure upon chains and trusses. The floor is 34 feet wide between the stiffening girders which are 8 feet high, forming the hand-rails. The stiffening girders have expansion joints every 100 feet and are suspended from the chains by flat bars 20 feet apart. At the expansion joints there are struts instead of suspenders in order to make a rigid connection between the roadway trusses and the chains. Cross-girders, 3 feet in depth, connect the stiffening girders every 20 feet, and support two lines of iron stringers. These stringers and the roadway trusses form the bearers across which are placed the wooden joists for the flooring.

The lateral stiffness of the floor is secured by a double system of tie-rods, and the wind pressure will be taken up by horizontal steel wire cables, placed under and connected to the floor.

The towers are entirely of wrought iron, except the bases of the columns. A cross-section of one of the columns is shown in the engraving, four of which, 30 inches square each, are connected by lattice bars and form the tower. The chains are carried over the top of the tower on wrought iron chairs or saddles which are movable on rollers to allow for expansion and the elongation of the back chains under strain.

The bridge is proportioned for a moving load of 1600 pounds per lineal foot, under which, together with the weight of structure, the chains will be strained to 12,000 lbs. per square inch, sectional area. The suspenders and roadway members are strained only from 8,000 lbs. to 10,000 lbs. per square inch. The maximum compressive strains in the towers are 9,000 lbs. per square inch.

The bridge will be finished by the end of this year, and we shall in a later number, give a full description of its construction and erection.

THE FULLERTON AVENUE CONDUIT.

A History of the Various Drainage Schemes of Chicago With Critical Notes on the Conduit at Fullerton Avenue.

By LYMAN E. COOLEY, C. E.

Written for Engineering News.

II.

New specifications were issued July 14, 1875, and being a model of their kind we insert them in full. To the specifications were attached a schedule of the plant of Norris & Co.

SPECIFICATIONS.

LOCATION AND GENERAL DESCRIPTION.—The land portion of the couduit is to extend along Fullerton Avenue, south of the center line of said Avenne, from the end of the brick work forty (40) feet east of the east line of Racine Avenue, to the ***land shaft*** at the lake shore drive; being sixty-five hundred and fifty (6,550) feet in length, more or less. To be circular in section with an inside diameter of twelve (12) feet. It is to be level throughout, with the inside surface of the invert thirteen (13) feet below city datum.

There is to be a man-hole at each street crossing and at other points shown on plan "A," provided with junctions or entrances for sewers, as shown on plan "B."

The lake portion is to extend in line of the land portion of the conduit prolonged, nine hundred and fifty (950) feet more or less under Lake Michigan. To be the same in diameter and section as the land portion of the conduit, with the inside surface of the invert forty-three (43) feet below city datum, as shown on plan "C."

EXCAVATION.—The excavation for the land portion of the conduit is to be made to a depth of twelve (12) inches below the bottom of the masonry wherever required, and of such width as to admit of the masonry for the conduit being built of the size and in the manner hereafter to be specified.

For the portion that may be tunnelled, the excavation is to be made of such size as to fit the outside of the brick lining.

All excavated material, not required for back-filling, to be the property of the contractor and must be removed from the street as soon as possible after the completion of each one hundred (100) yards in length of the work, in such a manner as to save the city from all damages, or liability to damages on account of the same.

All water or gas pipes, of whatever kind or size, to be carefully supported, and protected from injury, by the contractor, either until the masonry and back filling shall be finished, or till the officers of the water or gas works shall remove or change the pipes.

Said pipes shall be replaced as soon as practicable after the completion of a sufficient portion of the work; and the contractor shall bear all expense and pay all damage which either private individuals or corporations shall incur in changing, removing or replacing them.

All gravelling, macadamizing, planking, sidewalks culverts and cross-walks, or any street paving or walks whatever, are to be carefully removed by the contractor before the excavation is made, and are to be restored again as the work progresses to as good a condition as they were in previous to the beginning of the work, and to the satisfaction of the Board of Public Works, if in the City of Chicago, and to the satisfaction of the Trustees of the Town of Lake View, if in Lake View.

BACK FILLING.—As soon as practicable after any portion of the masonry work of the conduit is built, the trench over the arch shall be filled up by the contractor, as the work progresses, in uniform layers of not over two (2) feet in thickness, to a height sufficiently above the former surface of the street to secure, after settling has taken place, the same elevation of surface that existed previous to the excavation of the trench, and in such manner as to leave a smooth, even surface for the street.

The trench shall be kept filled as close up with brick work as possible so as to leave the least practicable length of street in a bad or impassible condition at any one time, and the whole street is finally to be restored to a condition as good as that in which it was found. Immediately after the arch of the conduit is closed up at any given point, as the work progresses, the spandrels of the arch shall be carefully filled in layers of not over six (6) inches, and thoroughly rammed, to the height of the arch so as to leave no vacancies between the masonry and the sides of the trench.

The contractor will be required to fill, with the surplus earth taken from the trench, and without extra expense to the city of Chicago, that portion of the street, now unfilled, which is west of the present terminus of the masonry of the conduit, between Racine Avenue and Southport Avenue, and also the sand pit, excavated on the line of Fullerton Avenue, between Franklin Street and the lake shore. This filling is to be done in accordance with the foregoing specifications for back filling.

CONDUIT PROPER.—Both the land portion, and the lake portion, of the conduit is to be of brick masonry sixteen (16) inches in thickness. The masonry to be of hard-burned, clear-ringing, well formed bricks, free from lime, of the usual size used for construction of sewers in this city. The bricks to be laid in the best cement mortar, in four (4) rings or shells, to be longitudinally with the conduit, with the edges toward the center and with toothing joints. The cement to be equal to that known as the best of Clark's La Salle, of past years, and not merely the best that may happen to be in the market for the time being. The mortar is to be made by mixing two measures of clean sharp sand with one of cement, and used as soon as possible after being mixed. The bricks must be clean and thoroughly wet if required before being laid. Those having smooth surfaces to be used on the inside face of the conduit, and to be laid fair and smooth by line and to a true cylindrical form.

All the joints in the masonry must be perfectly filled by pressing the brick into the cement mortar, and not by pressing the mortar between the bricks.

The joints between the courses shall not exceed half an inch in thickness, and between the rings or shells they shall not be less than half an inch in thickness.

All the mortar joints to be carefully struck and smoothed with the surface of the bricks; the refuse mortar to be scraped off, and with the rubbish of every kind and description to be removed entirely from the conduit, which must be left perfectly clean and unobstructed.

Whenever the soil is sufficiently firm the masonry for the conduit is to be laid directly on the bottom of the excavation; but whenever this shall not be the case, the contractor shall put in place, sand, gravel, or other suitable material, as may be required by the Board of Public Works.

In tunnelling all spaces left between the outside of the regular brick work and the side of the excavation, must be filled up solid with masonry, but no allowance will be made for such extra work unless caused by the mistake of men employed by the city to look after the work.

Sufficient means must be provided by the contractor to keep the work dry until the cement is perfectly set.

MAN-HOLES.—There will be in all fifteen (15) manholes—one at the intersection of each street and at other points as shown on plan "A." To be six (6) feet in internal diameter at the bottom and three (3) feet at the top. Each man-hole to be cylindrical from the bottom to within six (6) feet of its top, from which point it will taper to the top as shown on plan "B."

The masonry to be composed of brick and cement mortar, and to to be eight (8) inches in thickness. The material for the masonry, and the manner of laying it, to be in every respect of the kind, and quality, specified for the conduit proper, except that the brick are to be laid flatwise, in horizontal courses, with their ends towards the center.

Junctions, or entrances for sewers, to be built into the man-holes, at the points and of the sizes, that may be directed by the Board of Public Works.

The ends of junctions to be carfully closed with brick and cement mortar in the usual manner for such cases.

The intersections of the man-holes with the conduit and of the sewers with the man-holes to be neatly groined.

The man-holes to have covers made of three thicknesses of three inch white oak plank, as shown on plans, and to be provided with ladder irons of the number and size shown.

THE LAND SHAFT—Will be located west of and near the west line of the Lake Shore Drive, the bottom proper to be forty-three (43) feet below city datum, to be circular in section, and to have an internal diameter, as follows: Six (6) feet at the top, twelve (12) feet at a point ten (10) feet below the top and twelve (12) feet from the same point to the bottom, as shown on plan "C."

The masonry for the upper ten (10) feet of the shaft is to be twelve (12) inches, and for the lower forty-two (42) feet sixteen (16) inches in thickness. The masonry is to be composed of brick and cement mortar, the brick laid in horizontal courses, in other respects to be the same as for the conduit proper. The groining must be neatly and smoothly done, and all the masonry made in the best and most workmanlike manner.

There is to be built into the masonry of the shaft wrought-iron steps, or rounds, to form a ladder from bottom to top, in form, number and dimensions as shown on the plan.

The shaft is to have a wooden man-hole cover composed of three thicknesses of four (4) inch white oak plank, made in the usual manner, but so as to leave an opening as large as possible when the lid is off.

Below the bottom proper of the shaft is to be a sump, six (6) feet in diameter, and four (4) feet in depth.

LAKE SHAFT.—To be twelve (12) feet in internal diameter from top to bottom, to be circular in section; when sunk to its place the top of the shaft to be four and one-half (4½) feet below city datum, or about six and one-half (6½) feet below ordinary water in the lake. The upper twenty-four (24) feet of the shaft, is to be made of a cast-iron cylinder, lined with brick masonry. The cylinder to be made in three sections, each eight (8) feet in length, and fourteen (14) feet in diameter, and one and one-quarter (1¼) of an inch in thickness, bolted, one to another by means of flanges, twelve (12) inches in breadth, by one inch in thickness. Each section is to be strengthened in the middle by means of a horizontal rib, twelve (12) inches wide by three-quarters (¾) of an inch in thickness.

The connecting flanges to be cast with an annular offset one quarter (¼) of an inch by four (4) inches, as shown on plan "C," the offsets to form a space one-half (½) an inch by four (4) inches for making a water-tight joint, which shall be done by caulking with lead.

The bolts connecting the sections to be one and one-quarter (1¼) inches in diameter, to be made of the best wrought iron, about twenty bolts being used to each joint.

The iron employed in the construction of the cylinder to be equal in quality to that used in the cylinders of the lake tunnels.

The castings to be uniform in thickness and free from all defects.

The bottom of the lower sections of the cylinder is to be made in the shape of a cast iron shoe, as shown on plan, the shoe to be three-quarters (¾) of an inch in thickness.

The flanges on the top of the upper sections of the cylinder are to be cast with an inclination of forty-five (45) degrees with the axis of the cylinder, as shown on plan, and to be dressed to a true conical shape, to form a seat for the cylinder cover.

After the cylinder shall have been sunk to its place by excavating the material from within, and the water pumped out, it is to be lined with brick masonry twelve (12) inches in thickness. The brick portion of the shaft below the cylinder is to be made in the same manner, and shape, in every particular as the corresponding portion of the land shaft; except that there will be no sump, all the masonry in the lake shaft to be of the character specified for the conduit; and to have ladder irons built into it, of the size and distance apart as those in the land shaft.

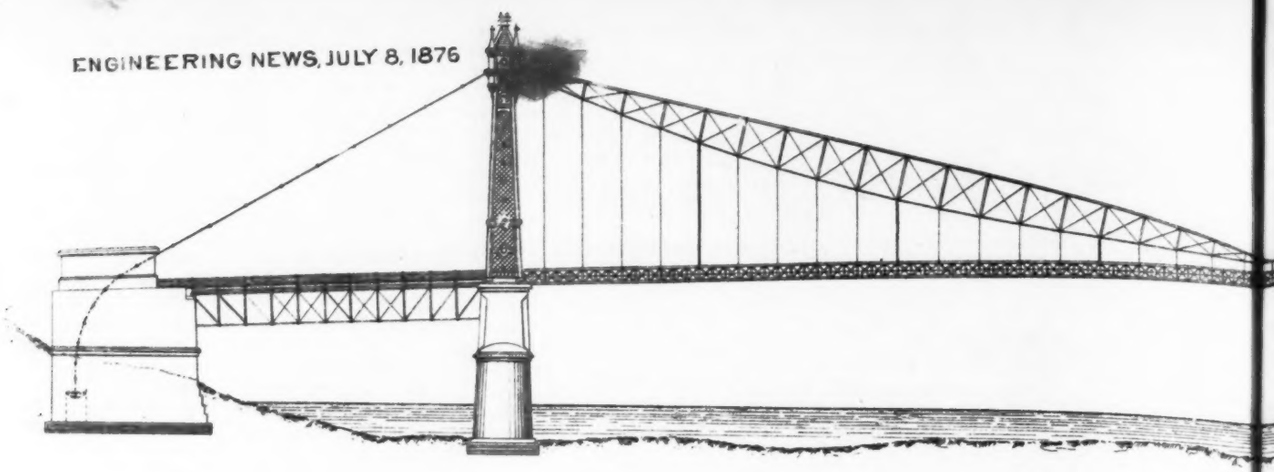
CYLINDER COVER.—The cylinder cover is to be made of one-quarter (¼) inch boiler plate iron and a three (3) inch by four (4) inch angle iron, weighing eleven (11) lbs. per foot, put together with rivets, one-half (½) inch in diameter, as shown on plan "C."

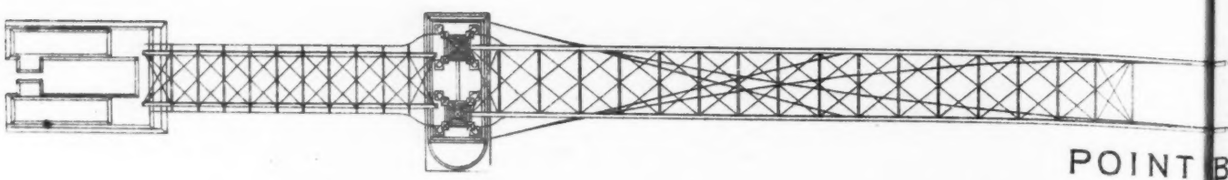
The upper part of the cover will be cylindrical and the lower part, conical, in shape. When in place on the shaft, the top of the cover shall be five and one-half (5½) feet above city datum.

The angle iron shall be bent in the shape of the cover seat on the top of the cylinder, and riveted, as shown on the plan, to the conical part of the cover.

Around the outside of the angle iron, circular segments of white oak timber, four (4) inches square will be bolted; to the timbers, a strip of India rubber, one (1) inch thick and four (4) inches wide will be nailed, the whole forming a water-tight joint between the top of the cylinder and the cover.

The cover is to be suspended in the center of the cupola, of the pier house, directly over the centre of the shaft, so that it can be raised and lowered, by means of a wire rope three-quarters (¾) of an inch diameter, and sixty-six feet (66) in length. The cover will be guided on its ascent and descent by means of lugs riveted to the cover and sliding against two upright T irons three (3) inches by four (4) inches, the irons being bolted to the outside of the cylinder, and secured to the roof of the house. The rope, one end of which will be secured to the cover, will pass over a pulley attached to the center timber of the cupola—thence over three guide pulleys attached at its other end to a winding drum, on the floor of the pier-house, which is to be so geared with a crank, and pinion, that one man can readily raise the cover.

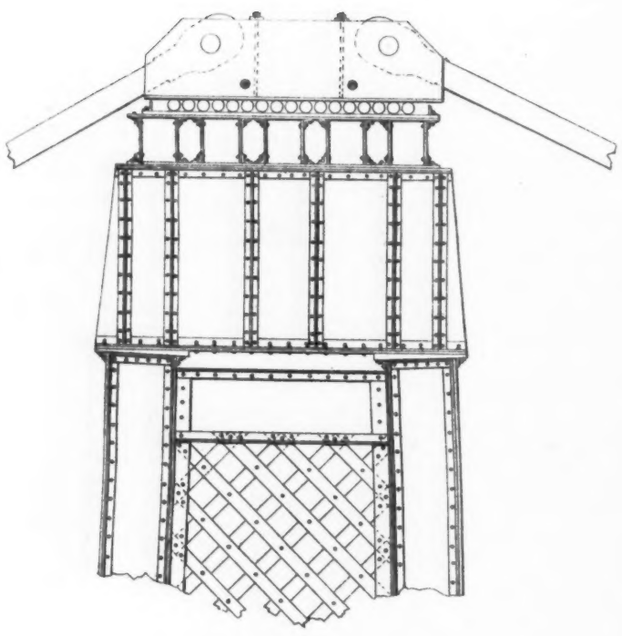




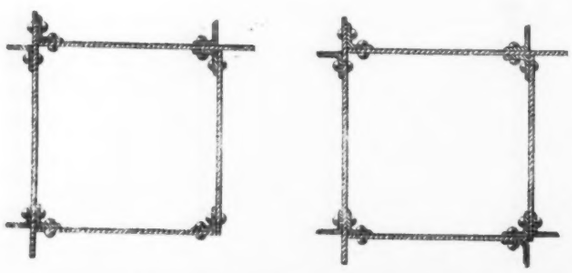
POINT B

OVER THE MONONGAHELA RIV

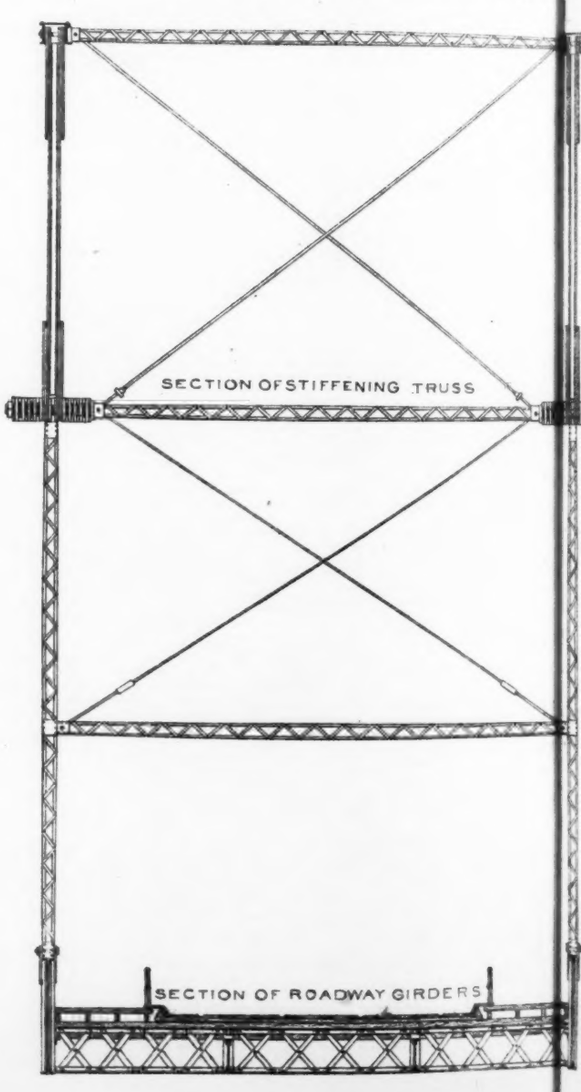
THE AMERICAN BRIDGE CO., NEW YORK AND

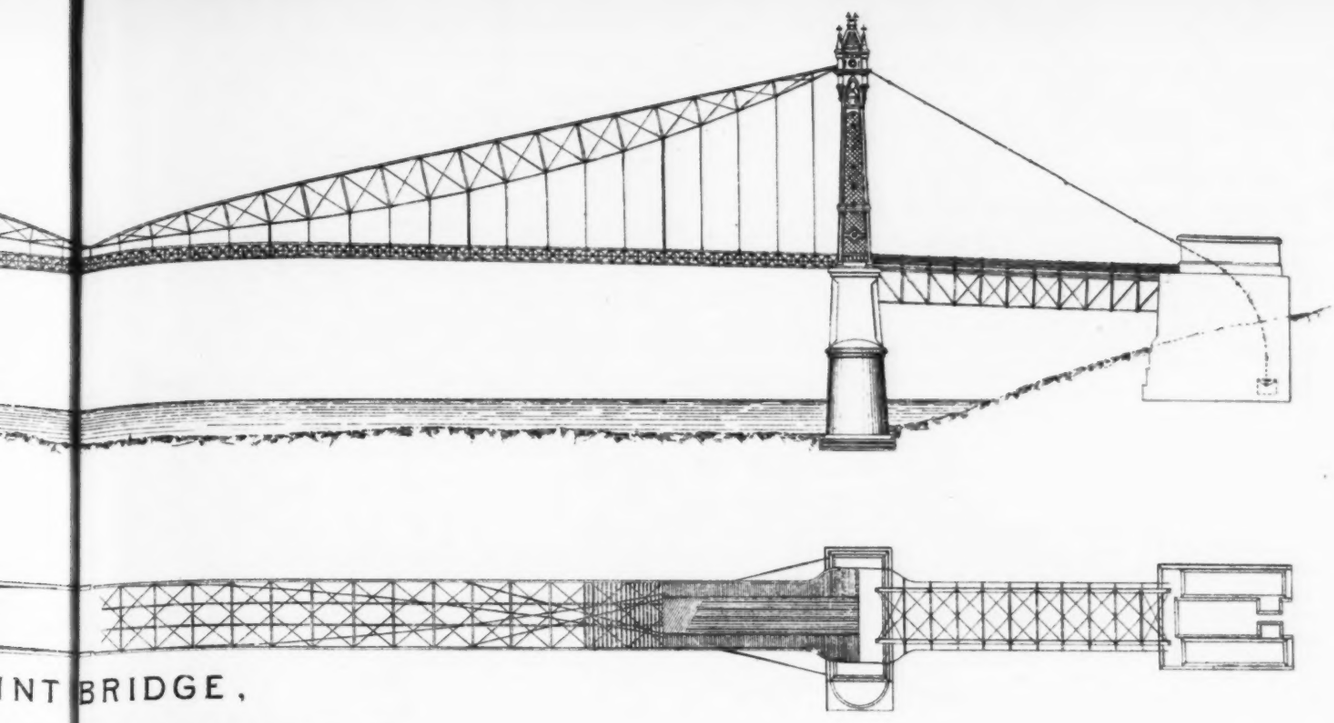


CONNECTION OVER TOWER



SECTION OF TOWER COLUMNS

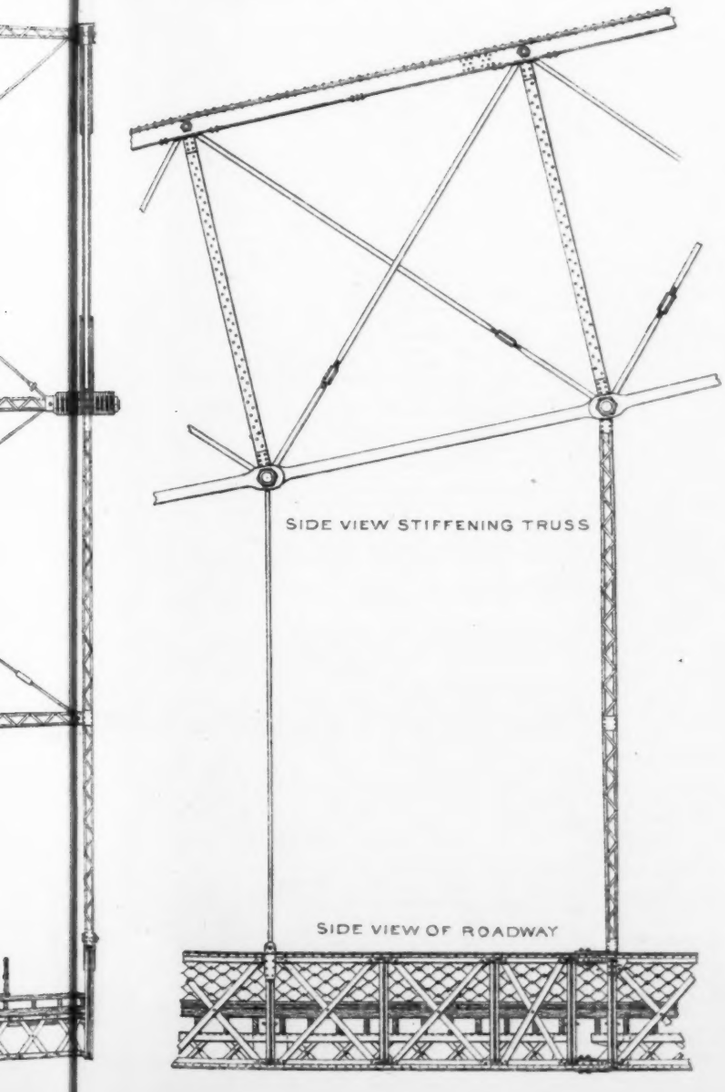


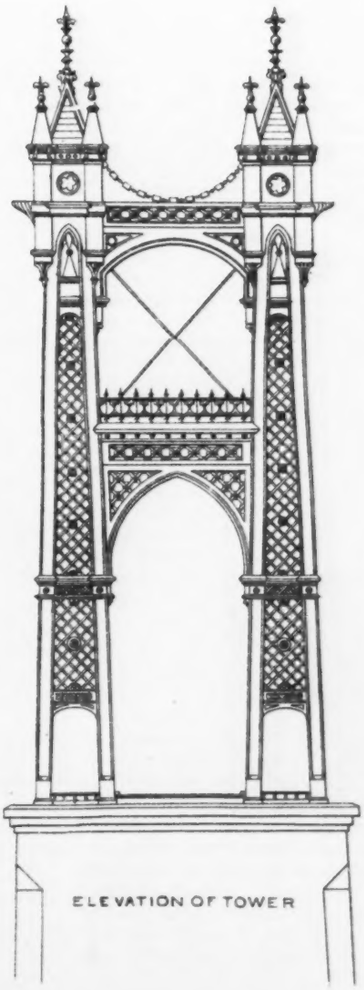


INT BRIDGE,

HELA RIVER, AT PITTSBURGH, PA.

YORK AND CHICAGO, ENGINEERS AND BUILDERS.





PIER.—The pier in which the lake shaft is to be located, is to be of the shape shown on plan "C," to be one hundred (100) feet in extreme length, and thirty-five (35) feet in extreme width, composed of one outside row of piles, one inside row, driven four (4) feet from the outside row, and parallel to it, and two cross rows, one at each end of the rectangular portion of the pier; the piles in the rows to be two (2) feet apart from center to center. Each row of piles will be capped with a twelve (12) inch by twelve (12) inch white oak timber, bolted to each pile, with a one (1) inch square drift bolt twenty-four (24) inches long, the top of the caps being eight (8) feet above city datum. Seventeen twelve (12) inch by twelve (12) inch white oak timbers will extend across the pier from side to side, being dovetailed with the outside caps, and notched with he inside ones, and also with the top timbers of the gate chamber, with a half and half notch, as shown on plan "C." Immediately around and over the shaft twelve (12) inch by twelve (12) inch white oak timbers will be framed so as to form an octagon shaped opening fifteen (15) feet in diameter; into these timbers, post will be framed, and a top railing three (3) feet high, with two intermediate railings made to surround the opening. A floor of three (3) inch white oak plank will be spiked to the cross timbers and caps, by means of six (6) inch wrought iron spikes, two spikes to each intersection. Trap doors, with hinges and fastenings, are to be made in floor at such points, and of the size designated, so as to render the gates and other parts accessible.

The piles for the pier are to be white oak, straight, and not less than ten (10) inches in diameter at the small end, and not less than thirty-five (35) feet in length. To be driven twenty-five (25) feet below city datum. They are to be shod with iron, if necessary, each shoe to weigh not less than twenty-five (25) lbs. The bark is to be taken off of all that portion of each pile above low water.

PIER HOUSE.—An eight-sided house shall be erected upon the pier, over the mouth of the shaft. The house to be twenty-five (25) feet in diameter, and thirty-three (33) feet in height from the floor to the top of the cupola. The roof both of the house and cupola is to have a slope of forty-five (45) degrees.

The timbers composing the frame are to be of the sizes marked on the plan "C," and are to be put together in the best manner, with mortise and tennon, and notches, as the case may require.

The sills are to be bolted to the timbers of the pier by means of sixteen one and one quarter (1¼) inch wrought iron bolts with nuts and washers. A strap of iron one-half (½) inch thick by three (3) inches wide, is to extend around the cupola, just under the rafters, the ends connected by means of a clamp bolt.

The points of the main posts of the house, with the plates, are to be strengthened by means of strap-irons one-half (½) inch in thickness by four (4) inches wide, bolted to the plates by means of four, one and one-quarter (1¼) inch bolts at each joint. The house, including the cupola, is to be weather-boarded with dressed upright boarding of clear pine lumber, one inch in thickness and eight (8) inches in width, the joints battened with three (3) inch strips. The rafters for the roof to be as shown on plan; to these a sheeting of inch boards is to be nailed, and shingles nailed to the sheeting, so as to expose to the weather four (4) inches of their length.

There shall be four (4) windows, two and one-half (2½) feet by five (5) feet, made in the sides of the house, and one door with suitable hinges and fastenings at each point, as may be designated.

GATE CHAMBER.—A gate chamber, fourteen and one-half (14½) feet in height, thirty-eight (38) feet long, and twenty-one (21) feet in width, is to be constructed, and sunk inside the rows of piles forming the pier, and around the shaft. The inside of the bottom of the gate chamber is to be even with the top of the cast iron cylinder, that is, four and one-half (4½) feet below city datum, when both are in place, as shown on plan "C." The chamber to rest upon two (2) rows of piles cut off at the proper depth, as shown on plan "C." The frame of the gate chamber is to be made of pine timber, of the sizes marked on plan "C," put together as shown, with mortise and tenon, spikes and bolt. About twenty-four (24) bolts, one and one-half (1½) inches in diameter and twenty-four (24) inches to thirty (30) inches long, with nuts and washers will be required in the bottom to hold the longitudinal and cross-timbers firmly together. The inside of the chamber to be lined with four (4) inch white oak plank spiked to the frame with seven (7) inch ship spikes. The edges of the plank to be jointed, tongued and grooved, and made water tight with red lead.

In the side of the chamber toward the lake, six (6) openings, each five (5) feet and two (2) inches long, and three (3) feet and six (6) inches high, in the clear, will be left, the outside face of which will be inclined as shown on the plan, and so fitted with the gate as to make a water tight joint.

The method of making the gate is shown on plan "C." The timbers used to be of the best white oak. The two inch white oak plank to be tongued and grooved, and to be put together with red lead in the joints, so as to make them water tight. Each gate will be hung by means of a one and one-half (1½) inch round iron rod, five (5) feet and eight (8) inches long, passing through cast iron eyes which are inserted in the ends of the gate timbers, which ends are strapped with wrought iron straps one-half (½) by three (3) inches, and thirty (30) inches long, bolted to the timbers with one inch bolts. The ends of the rods to rest in sockets of cast iron which are bolted to the posts by means of one and one-quarter (1¼) inch bolts.

The rods to be held in their sockets by means of a block of cast iron, and a key, as shown in the detail plans.

After the pier is built, and the shaft sunk to its proper depth, the gate chamber will be sunk to its position, and the joints between the floor of the chamber and the shaft must then be made water tight, so as to allow the water inside the gate chamber to be pumped out.

The gate chamber to be secured in its place by means of wedges and bolts between the outside of the frame and the piles of the pier.

RIP RAP.—The space immediately under and in front of the gates, to a point four (4) feet beyond the outer row of piles, shall be filled with *rip rap*, from the bottom of the lake up even with the bottom of the gate chamber.

SPECIAL AND GENERAL REQUIREMENTS.—All materials of whatsoever kind, to be used in the work, are to be subject to inspection by the Board of Public Works, and all unsuitable materials are to be immediately removed by the contractor. The contractor shall discharge from his employment, when directed by the Board of Public Works, all unfaithful or incompetent workmen or overseers.

The Board of Public Works must be permitted to remove such portions of the work as they may from time to time think necessary, for the discovery of improper materials or workmanship; and the contractor shall restore such work at his own expense, in case it shall have been done improperly, and at the expense of the City of Chicago if done in a proper manner.

The contractor shall furnish all the pumping, transporting ventilating, hoisting, pile-driving, and other apparatus and machinery; all the tools, all the materials, and whatever else may be needed, and do all the work, of whatsoever nature, necessary to complete the Land and Lake portions of the conduit, the shafts, pier, and gate chamber, pier house, and all other work named in these specifications, and to protect the work duriug its construction.

The contractor shall furnish men and stakes sufficient to enable the Engineer of said Board to give the necessary lines and levels to construct the work by, and shall convey him or any employe of said Board, up and down said shafts, without charge for them, or for any necessary delay of the work while giviug lines or levels.

The contractor must deliver to the Board of Public Works, on or before the first day of each month, a written statement of the amount of claims, if any, for extra work done, and extra materials furnished during the previous month, or for extra expenses incurred from any cause whatever, otherwise claims for extras during that month will be forfeited and waived.

The contractor will be required to guarantee that the work will stand in good order against all casualties, for twelve months after the same shall have been faithfully completed to the satisfaction of the Board of Public Woaks, and to keep the work in perfect repair for that time.

Monthly estimates will be made by the Board of Public Works of the value of the work actually done and in its permanent place, and on or about the sixth day of each month, vouchers for eighty-five per cent. of the estimated value of the work done the previous month, will be issued, the remaining fifteen per cent. to be reserved until the completion of the whole work.

The contractor shall permit no excrements, or offal of any kind, whatsoever to be deposited any where in the conduit or on the streets.

The contractor shall immediately discharge any person in his employ who shall be known to commit a nuisance on, or near the work.

The contractor will be required to guard the public effectually from liability to accident, in consequence of his operations, during the whole progress of the work, both by night and by day, and will be held responsible for any damages the city may have to pay in consequence of neglect on the part of the contractor, to protect the public against such accident.

The contractor will also be held responsible for all damages said city may have to pay to private individuals or corporations, in consequence of any of the acts or doings, or neglect, of said contractor, in connection with said work. The contractor is to confine his operations within the limits of the street line. In front of all buildings, a sufficient foot-way for ingress and egress, to be kept clear.

The contractor will not be allowed to interrupt the regular use of the tracks upon the North Chicago City Railway any longer than may be absolutely necessary for the prosecution of the work, except by the consent of the directors of said railway, and must do whatever may be necessary to avoid such interruptions without extra expense to the City of Chicago.

The Board of Public Works reserves the right to make any changes in the foregoing plans and specifications that the said Board may deem desirable or necessary, and the contractor shall furnish any additional materials, and do any additional work required by such changes, at the rates said Board shall determine to be just.

The contractor shall, at his own expense, pump out the present finished portion of the conduit, and continue to pump out the same as long as may be necessary.

The work is to be begun and carried on at such times and places as said Board shall direct, and the whole of it is to be completed by the

FIRST DAY OF DECEMBER, 1876.

In accordance with an ordinance passed by the Common Council of the city of Chicago, June fourteenth, 1875, the contractor will be required to take the plant, and materials of George F. Norris & Co., the former contractors for said conduit, at the appraised value, amounting in the aggregate to twenty-four thousand five hundred and eighty-seven dollars and ninety-five cents ($24,587.95,) which said amount is to be retained by said city, out of the vouchers issue upon the first estimates on the work done. A schedule of said plant and materials is hereunto attached.

A part or the whole of the land portion of the conduit—that is, that portion between Racine Ave. and the lake shore drive—may be tunnelled if the contractor chooses, under the following provisions and restrictions, viz: whatever portion is tunnelled must be continuous, when completed, from the land shaft westward.

In such case, the tunnel to be in shape, size, and material, the same as herein specified for the conduit, and all provisions and requirements which apply to the one, are to be considered in full force and application to the other, in so far as the work, when completed, is concerned.

In case of tunnelling, the contractor will not be allowed to lower the grade of the conduit to a depth of more than forty-three (43) feet below city datum at any point, or thirty feet below the present grade of the conduit. Nor shall the grade in any case be allowed to ascend from west to east, either by a regular slope or an abrupt change.

If the passage from the present grade of the conduit, to the grade desired for the tunnel, is by means of a vertical shaft, said shaft and its manner of being connected with the conduit, both above and below, shall in all important respects be as specified for the land shaft.

The contractor may sink intermediate shafts at such street crossings as he may think necessary for the early completion, or convenience in prosecuting the work.

All these shafts shall be provided with ladder irons, and be tapered at the top, and covered as specified for the land shaft.

All the man-holes (specified for the conduit in case the work is done by open cutting) must (in case tunneling be adopted) be continued down to the tunnel, the same size, and with the same character and manner of workmanship required in case the work is done by open cutting.

Parties bidding for the work must do so in accordance with the following form of proposal:

The word conduit, as used in the proposal, is to be understood to include not only the conduit proper, with the excavation, bracing, sheeting, back-filling, and restoration of all streets, street-surfaces, sidewalks, gas and water pipes, whatsoever; but also the man-holes, and all shafts made necessary by doing the work by tunneling instead of by open excavation, (in case it should be so done), and the restoration of all grass plats or surfaces, trees, ditches and fences, to as good a condition as they were in before the beginning of the work, to the satisfaction of the Board of Public Works. The actual quantity of each kind of work done and material furnished, may be more or less than the corresponding quantity given in the proposal, but no variation will be made in the rate on that account.

It will be perceived that in these specifications, the lake part and outlet including pier house are added and also, that the contractor may use his option as to whether he shall tunnel the whole distance or make a portion by open cut. Twenty-five bids were received the six lowest of which were as follows:

Fitzsimon & Connell	$314,201.00
E. Earnshaw	338,062.00
William D. Coxe	338,187.50
A. H. Jones	363,020.00
D. P. Curran	369,309.50
E. F. Gobel	401,713.00

The contract for the entire work described in the specificattons was let to Fitzsimon & Connell for the sum of $314,201.

The following proposal gives an analysis of his bid.

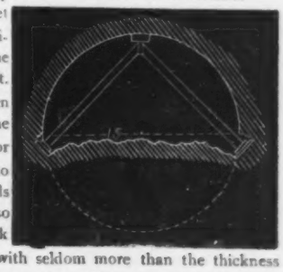
I hereby propose to do all the work, and to furnish all the materials and machinery necessary to construct the Land Portion of the Fullerton Avenue Conduit, between Racine Avenue and the Lake Shore Drive, the Lake Portion, the Land and Lake Shafts, the Pier, the Pier House, the Gate Chamber, and all necessary appurtenances, according to the plans and specifications for the same on file in the office of the Board of Public Works, and to the satisfaction of said Board, at the following rates, viz:

		Rates		Totals.	
		$	c.	$	c.
6550	lineal feet of the Land Portion of the Conduit, per lineal foot	40	00	262,000	00
950	lineal feet of the Lake Portion of the Conduit, per lineal foot	40	45	38,427	50
56	lineal feet of Land Shaft and Sump complete, per lineal foot	36	00	2,016	00
39	lineal feet of Lake Shaft, complete, including Cast Iron, and Bolts in Cylinder, per lineal foot	158	50	6,181	50
222	Piles, 35 feet long, per pile driven	12	00	2,664	00
10	Piles, 25 feet long, per pile driven	12	00	120	00
24	M feet B. M. Pine Lumber, framed and in place, per M	26	00	624	00
29	M feet B. M. White Oak Lumber, framed and in place, per M	35	00	1,015	00
10	M Shingles, Pine, per M	5	50	55	00
9000	lbs. of Wrought Iron—Bolts, Nuts, Bars, and in Cylinder Cover, Guides and Windlass, per lb.		08	720	00
1600	lbs. Wrought Iron Spikes, per lb.		08	128	00
2000	lbs. Cast Iron, 6½c. per lb.			130	00
20	cords of Rip Rap, per cord	6	00	120	00
Total				314,201	00

The first $24,587.95 due the contractors was paid to Norris & Co. by the city as provided in the ordinance.

The nature of the work is so well described in the specifications that no further description seems necessary. The contractors have sunk three shafts, one about 150 feet west of the lake shore drive, one at Larrabee Street and one at Sheffield Avenue. At the lake shore shaft they have gone down 56 feet below datum, somewhat further than provided for in the specifications and no doubt much safer for the lake tunnel. Such success was met at this shaft that they have concluded to tunnel the whole distance. The tunnel is in very solid clay with occasional pebbles and pockets of sand and water. At the Larrabee Street shaft it was intended to keep above the rock, but after the shaft was sunk, in attempting to groin in the tunnel headings, too little support was left for the shaft and it sunk down bodily, necessitating the lowering of the grade of the tunnel several feet at this point. The Sheffield Avenue shaft is just completed and about 50 feet driven each way. At Racine Avenue the junction of the completed work will be made with the tunnel, 15 feet below, by a reversed or goose neck curve. The profile annexed will give a clear idea of the ground through which the tunnel runs, the sand, clay and rock, the position of the shafts and the grades of the tunnel. The shaded portion represents the completed part of the tunnel. The unshaded part is liable to alteration as circumstances may require. There is completed at the present writing * 990 feet east from the lake shore shaft and 1250 feet west; 250 feet east at Larrabee Street shaft, and 120 feet west, and 50 feet each way at Sheffield Avenue shaft. About 4,800 feet yet remain to be completed.

The tunnel, where in the clay, has been driven at about an average rate of 8 feet per day except in an occasional soft place where much care is required. The men work in three shifts of eight hours each: first, the miners; second, the trimmers, and third, the brick-layers. The upper half of the tunnel is first removed to a distance of 3 to 8 feet, depending on circumstances. Then a heavy plank is placed longitudinally at the top of the tunnel and supported by two 8 by 10 inch shores which abut on short pieces of plank placed in holes dug in the sides of the tunnel at the top of the invert. After the shores are blocked up at the foot, a wedge is driven between them at the top, thus forcing the plank up solidly against the roof of the tunnel. The manner in which the shores are supported is illustrated in the sketch.



Usually one set of shores is sufficient to sustain the work of a shift. The bottom is then taken out and the work is ready for the trimmers who dress the clay walls very carefully so that the brick work is fitted to them with seldom more than the thickness of a mortar joint to spare. The gang of brick layers then come in. There are no special features in this shift to be described. The tunnel is so large that the mortar is mixed at the head of the tunnel and used immediately. When the brick are laid the platform or floor which is some three feet above the bottom of the tunnel is carried up to the face of the excavation and

*June 14, 1876.

the track laid. The centering which consists of battens supported by angle irons built so as to form a ribbed arch with the maximum of headway, is left in place until needed for the next shift of brick layers. The track is doubled near the head of the tunnel and also has a switch at the shaft. The cars are pushed along by hand and removed from the tunnel by an elevator at the shaft and run out on elevated side tracks from which the excavated material is dumped.

At the Larrabee Street shaft two thirds of the tunnel is in a sort of crystalline limestone. The progress averages 3 feet per day. The clay is first removed for a distance of 30 or 40 feet from the face of the rock and the roof of the tunnel turned, the arch simply abutting on the face of the rock. The holes are drilled by an Ingersoll drill driven by compressed air. Nitro-glycerine is the explosive used. Much care is required to prevent the blowing down of the roof of the tunnel. The rock is then more carefully trimmed by hand and light blasts, when necessary, to a true circular form. One ring of brick is then turned and all spaces filled up with solid masonry so that the interior of the tunnel appears the same as in the clay.

The writer is credibly informed that the actual average cost of the tunnel varies little from $25 per foot, notwithstanding the misfortune of the rock section. Although delayed by the accident at the Larrabee Street shaft, the work can be completed by the time specified if the Common Council furnish the money. We understand that it is not the intention to complete more than the tunnel portion at present, as no appropriation is available for constructing the crib and outlet in the lake. We sincerely hope that the Common Council will fully appreciate the needs of its early completion, not only from a sanitary point of view, but also to remove it at an early day from the atmosphere of fraud which has always unfortunately surrounded it, and the criticisms of croakers who always see failure in what they do not read as they run. We believe it is the intention of the present contractors to do an honest job. Be that as it may, it was a great misfortune to find a couple of weeks since that at least 600 feet of the tunnel near the lake shaft, where the pressure from superincumbent earth is greatest, had only two rings of brick laid carefully in cement; the third ring laid at random with more or less cement, and the fourth ring thrown in loose. In some spots the third and fourth rings of brick were simply set on end with no cement at all. Who is to blame? Certainly not the engineers, for it was impossible for them to be constantly present. It was impossible for it to happen without the knowledge of the two city inspectors who were supposed to see all the brick laid. The damage is done and the trouble lies deeper than the surface. We suspect that it lies in the fact that irresponsible officials can appoint men on public works contrary to the advice of the Board of Public Works or the City Engineer. We believe that to be the fact in this case.

It seems impossible to remove the condemned portion without endangering the tunnel, as the clay has probably considerably softened. No doubt the best way to repair it would be to turn an extra ring of brick on the inside which is entirely feasible and comparatively inexpensive.

Some points of scientific interest merit description. The rock at the Larrabee Street shaft is level and polished as a floor, with well marked glacier grooves trending southwest by west. This rock is very strongly impregnated with petroleum. Solid nodules of bitumen are frequent and also occasional cavities containing petroleum and gas. We have shown the rock profile in the profile of the tunnel as nearly as can be ascertained. Near Clark Street the rock dips quite abruptly to the southeast; east of Racine Avenue the clay line is quite irregular as if eroded. The sand line dipping down at Racine Avenue was the cause of complaint of Norris & Co.

The tunnel is remarkably dry throughout, the dryest portion being under the lake. One spring was met a few huudred feet west of the lake shaft. This was let through the masonry by a 1¼ inch pipe which it nicely fills with clear water. Some water seeps in at the shafts from above but of no great amount. No water is found at all in the clay except the spring referred to.

The pneumatic tube, for the transmission of messages between Paris and Versailles, which has just been completed, is nearly thirteen and one half miles in length.

NOTES.

Eau Claire, Wis., is to have gas works.

A Cincinnati firm expects to manufacture 40,000,000 of flags this year.

The first through passengers per Intercolonial Railway from Halifax arrived in Montreal on the 5th inst.

Boys and girls under 10 years of age are not hereafter permitted to work in the factories of Massachusetts. The law passed by the legislature on the subject has gone into effect.

The new Chicago Directory contains 153,335 names Estimating the population at 3½ for every name, which is considered low, Chicago has a population of 536,673, an increase of 25,172 during the past year.

Preparations are now making for a complete survey of the Erie Canal throughout its entire length. Cross-sections are to be taken every four rods, in order to ascertain its depth and general condition. It is intended to restore the canal to its original depth of seven feet,

$50,000 is asked from Congress by the Board for Testing Metals in order to carry on their experiments. The labors of the board have already resulted in benefit to the country. The principal testing machine now building by the Quintard Iron Works of New York is nearly completed.

The mass of iron in the main Centennial building amounts to 8,348,000 pounds, and the various kinds of straight and "T" iron, etc., would reach a distance of 141 miles; while if all the iron was made into a solid cube it would measure twenty-five feet and ten and one-quarter inches per side.

The works preliminary to the Channel Tunnel have been commenced at Saugathe, near Calais. Shafts have been sunk to a depth of forty metres. When these shafts have been sunk to the depth of one hundred metres a gallery, one kilometre in length will be made in the chalk in order to test the practicability of the tunnel.

Sewers were built in Somerville, Mass., in 1875 as follows, viz.: plank, 737 feet; clay pipe, 350 feet; cement pipe, 1,882 feet; brick, 12,137 feet; brick and timber, 1,049 feet. Total 16,155 feet. or a little over three miles. In these were built 36 man-holes and 648 inlets.

Total cost of the Engineering Department for 1875 was $4,131.69.

The town of Athol, Mass., is to have an extensive system of water works put in by the Athol Aqueduct Company, composed of Philadelphia and Greenfield parties. The water is to be brought from the adjoining town of Phillipston, a distance of between three and four miles from the lower village, with a total head of 510 feet.

The *Scientific American* is authority for the statement that the St. Louis and New Orleans express train, was struck by a tornado soon after passing Neoga, Ill., at 5:15 P. M., May 6, 1876, while running at 25 miles per hour and blown entirely from the track, the engine being partially displaced. But little damage was done to the track or the train, and strange to say, the passengers were not seriously injured.

The new park system for Boston is persistently pressed by the city papers, and they are backed up in this measure by men from every class of society, including the heaviest tax-payers. The City Council will be sustained in undertaking this improvement along with the sewerage system, and money can be obtained at very favorable rates

The assistant engineer, C. C. Martin, says the Brooklyn Bridge will be completed in three years. The tower and anchorage are completed on the Brooklyn side, and the tower and anchorage will be completed on the New York side during the coming month. In the first week of August the wires for a temporary foot bridge, for the use of the workmen, will be stretched. Work on the main cables will begin by October 1st.

M de la Bastie's toughened glass is in some respects less satisfactory than was at first supposed. It is true that it does not easily break, but it also cannot be cut. Several correspondents of the *Comptes Rendus* report that, on attemping to cut it with a wheel, drill or file, they found that it most invariably burst after the manner of a Rupert's drop. A disc of the toughened glass could be drilled at its centre without breaking, but it broke if pierced at any other point.

Prof. R. W. Raymond has prepaired a table showing the production of leading metals, etc., during the first century of the Republic; we quote:

Coal, Anth. tons of 2240 lbs				341,521,423
Pig Iron,	"	"	"	40,000,000
Lead,	"	"	"	855,000
Copper,	"	"	"	200,000
Quicksilver, in flakes of 76½ lbs				840,000
Petroleum, bbls. of 42 gals				76,594,600

An experiment is soon to be made on the British man-of-war, Thunderer, to test the efficacy of a network of iron wire with which it is proposed to encircle the ironclad war vessel of the future for purposes of protection. The netting is to be supported by booms at a distance of twenty-two feet from the sides, and kept rigid to below the depth of the keel by heavy weights. The danger to be guarded against is the fish torpedo, one species of which can be unerringly propelled under water for a mile, and will then sink a ship if it strikes her.

In architecture there is no majestic proportion, in column or obelisk, no fineness of curve, no ornament tracery in foliated arch, no solemnity of vista, no imposing vastness of dome, that did not originate from some fine quality of apprehension within the draughtman's soul. They are all flowers that have opened because of an inner element of bloom. They are all beautiful effects of a more beautiful cause. For whatever method of articulation the soul may take, whether of color, or vocal sound, or chiseled stone, it can never give perfect expression of its thought. These are only reflections of a a radiance whose original splendor no eye ever sees.—*W. H. H. Murray.*

On Saturday last, July 1, three representatives of the American Bridge Co., including Maj. Rust, Vice-President, had a conference with the directors of the Poughkeepsie Bridge Co.; $23,500 only, remains to be raised of the $500,000 necessary to close the contract. The American Bridge Co., then place upon the books their subscription of $500,000 which was agreed should be taken as soon as the first $500,000 was raised. Every arrangement was perfected for signing the contract on Saturday, July 8, provided the $23,500 is raised, which the directors of the Bridge Co. seem sanguine of accomplishing. If the contract is signed at the time specified work will commence as soon as the materials can be got on the ground.

The Fastest Cable Telegraphy.

On a recent occasion, when all the Atlantic cables were interrupted except the Direct, the entire business for two days were done on this one wire, and the average speed maintained for 48 successive hours was 10½ words a minute. The highest speed attained was 18 words per minute. Length of cable, 2,500 nautical miles. This is the fastest ocean telegraphy ever executed on a cable of equal length.

What is Bad Water?

Prof. Frankland answers, that every liquid is unwholesome or polluted, which (1) contains in suspension more than 1-100,000ths of dry organic matter, or more than 3-100,000ths of dry mineral matter; or (2) contains in solution more than 2-100,000ths of organic carbon, or 3-100,000ths of organic nitrogen; or (3) which, when placed in a white porcelain vessel to the depth of one inch, shows under daylight a distinct color; or (4) which contains in solution more than 2-100,000ths of any metal except calcium, magnesium, potassium or sodium; or (5) which contains in suspension, solution, chemical combination, or otherwise, more than 1-200,000ths of metallic arsenic; or (6) which, after the addition of sulphuric acid, contains more than 1-100,000ths of per chlorine; or (7) which contains more than 1-100,000ths of sulpher in the state of sulphuretted hydrogen or a soluble sulphuret; (8) which has an acidity superior to that produced by adding two parts of hydrochloric acid to 1,000 of distilled water; (9) which has an alkalinity greater than that produced by adding one part of caustic soda to 1,000 of distilled water; (10) which has on its surface a film of petroleum or hydrocarbon, or contains in suspension more than 1-200,000ths of such oils.—*The Polytechnic Review,*

Contractors' Intelligence.

The American Bridge Co., toook a contract this week for an iron Bridge on the Chicago & Alton R. R., at Springfield.

D. H. White of Vinton Iowa, has been awarded the contract for a new School building, in that town, for the sum of $11.986.

C. F. Lovelace of Iowa City has been appointed Superintendent of the contsruction of the new penitentiary building at Anamosa, Iowa.

Wm. White & Co., of this city have just completed the entire galvanized iron work and tin and slate roofing of the new Cook County Hospital in this city.

The Chicago Scraper and Ditcher Co., whose works are located at the pleasant Chicago suburb, Maywood, had sold this year, up to June 1st, 4,400 of their scrapers.

The contract for the entire construction of a section of the East Line & Red River Railroad, from Jefferson, Texas, eastward twenty miles, has been let to G. B. McDonald, of Jefferson.

Contractor's Plant.

BY ALEXANDER CLARK.

Paper read before the Edinburgh and Leith Engineers' Society

(*Concluded from page 216.*)

Scaffolding.—Scaffolding in engineering works often suggests a very rude and roughly-fixed platform without any particular design demanding special attention. For house buildings and the lighter class of bridges and similar works two very simple methods of scaffolding are often resorted to, one in which two battens or planks are bolted together with a short block between, on which a support is laid for carrying the planks which form the working platform, another in which round poles are used for both uprights and bearers, which are tied at the junctions with hemp ropes. So many matters, however, coming more directly under our heading, call for notice that we must leave the treatment of this subject, as well as the whole subject of "centering" for another occasion should you grant us the privilege of again addressing you.

The contractor's great enemy undoubtedly is water. To get rid of water, to keep clear of water, to dam back water, or to store up water, is in some form or other a description of a large part of the employment of engineers and contractors, and most likely will be to the end of time. If some chemical agent could be discovered which would turn water into a solid or gaseous form, just as required by the contractor, the discoverer would merit the unqualified laudation of all right-minded men, but in its common liquid form as water it often makes itself very disagreeable, especially if dirty, and of all dirty water, perhaps sewage is the most difficult to deal with. Sewers as a rule can be discharged with least trouble and expense at the place where they are not wanted, and a great problem at the present time is to find a pump, or wheel or lift of some kind, which may raise sewage a little in the world and enable it to shift for itself.

Model of Sewage Wheel.—We have prepaired a model of a wheel designed to raise sewage water, which we think overcomes the objections made to the greater number of machines of this class with which we are acquainted. The average lift was 11 ft. The wheel is constructed to be cast in four pieces, being 13 ft. diameter in centre of the inner and 16 ft. diameter on the outside of buckets. The rim to be convex, 2 ft. 6 in. broad, having 8 in. of curve. The buckets are 32 in number, having a curve of 1 ft. 6 in. along the rim of the wheel, and overlapping one another externally so as to form a solid outside rim, the water being admitted and discharged on the two sides only. The weight of the wheel was about 5¼ tons, and it was required to lift 500,000 gallons per diem, to be driven by a small turbine of 2½ horse power with an expenditure of 100,000 gallons per diem. This is very much within the the capacity of the wheel, for at least double this quantity could be raised without exceeding the revolutions per minute, a very moderate speed for the bucket to travel. We are not aware that a wheel on this principle has ever been in use, and we submit it for your consideration as a useful machine for low lifts without respect to the nature of the water to be raised.

Chain Pumps.—In sinking wells for excavation of river divisions or dock walls where large areas are to be drained or foundations sunk far below low-water level, the chain pump is undoubtedly one of the simplest, readiest, and most useful machines. One can be readily extemporised by cutting a tree or log down the centre, scooping out one-half the area of the pump disc from each side, and fastening it together again with iron straps. A strong wooden frame above for carrying the pitch-wheel and circular discs for attaching the chain complete the carpenter work. The chain and pitch-wheel can be made by any ordinary blacksmith without reeourse to any engineer's shop. These are great recommendations to a contractor who requires something easily made and repaired. Should the excavation be in sand it may be conveniently worked on the top of the cylinder, and with a man below shovelling the sand from the sides towards the centre, and a few tons of rails or pig iron as a load on the top, the pump will lift both the sand and water, and gradually sink with the cylinder into the ground. We have a sketch of a pump made and used in this way. No doubt better workmanship gives superior results so far as power is concerned, but for the object referred to the difference would not counterbalance the expense. When fitted up permanently they can be made to work tolerably smooth although never strictly speaking economically.

Centrifugal Pump.—Where an immense body of tolerably pure water has to be dealt with the centrifugal pump has nearly superseded all others both for economy and convenience. In the excavation of the diversion of the River Dee, Aberdeen, two pumps 15 in. in diameter and one 9 in. in diameter were used. One of the former when first started, driven by a portable steam engine of 25 horse power, having a lift of 12 ft., discharged water at the rate of 900,000 cubic feet per diem. As the excavations were sunk the lift increased but the discharge continued proportionate. The two great difficulties in working the centrifugal pump which have been the cause of its being considered troublesome to work, arise from the difficulty of getting the lower valve perfectly tight, and the trouble in keeping the pump filled with water owing to the leakage of the lower valve. Both these can be easily overcome. 1. The steam should be shut off suddenly so as to bring the valve down as quickly as possible. 2. Before leaving the pump the man in charge ought to observe by looking into the discharge pipe if the water is sinking in the pump, and if so the engine should again be started until repeated trials make it certain that the valve is perfectly close. 3. A bent rod for lifting the lower valve attached to a lever should be fastened to the pump, so that the valve may be lifted by hand should the stopping of the engine as proposed be ineffective. 4. A cistern for filling the pump should be placed immediately over the fan, connected by a branch pipe and supplied with a sluice. This should be kept constantly filled so as to be run into the pump when required. By observing these precautions the centrifugal may be as easily worked as any other form of pump and with more effect. We have seen as much as 20 cubic yards of sand pass through the pump in half an hour without injury, and should abundance of pure water be afterwards supplied this would form no obstruction in the way of stopping and again starting the pump.

We come now to the subjects of rails, wagons, and piling machinery.

Rails.—The service rails used on contractors' work are usually flat bottomed, varying in weight from about 22 lbs. to 35 lbs. per yard, and fastened with dogs 3½ to 4 in. long by ⅜ to ½ in. square. When chairs are used, which is only occasionally, they have usually no keys, or only a dog or spike driven in should the chair be too loose. The points and crossings are very simple in construction. The most simple is where a main line of rails is laid complete without break for either points or crossings. In this case the points are formed by a rail tapered off at the end laid on above the main rail, and at the crossing a gap is left so as to allow a wagon wheel to pass on the main line. Opposite this gap a strong check is placed on the outer leg of the rail into the siding, and where the siding again joins the main line it is thrown on by a check block without the tapering rail which is used at the opposite end of the siding. This form of siding is only used for empty wagons. A better form of crossing is, by the use of a sliding rail thrown over the main line, hinged at one end for convenience. Both these forms are inconvenient where there is much traffic, and the best form of crossing is similar to that used in permanent rails, having points with swing rails fastened with connecting rods, handle, &c. Three lines of rails can be run on to a bank for tipping wagons with a single switch of this form, and five hundred wagons in ten hours may pass along to the bank head in safety.

Wagons.—Tipping wagons are various both in size and construction. Many contractors have a particular form of their own to which they are generally partial. We have little time to describe the whole of them and shall only attempt to note a few of their differences.

1. Bogie wagons, or as they are called by the workmen fiddlestick wagons. Having only a single frame, their tipping joint is the front axle, the plummer block of which is constructed accordingly to suit. The axles are kept to their proper distance by a small frame about 2 ft. wide, which lies between the plummer blocks. These wagons stand very low, being only about 4 ft. 3 in. above the level of the rails. For this reason they are much more easily filled and are the lightest form of wagon, but as they require much more force to tip them at the bank end, they are not so much used as the high-flyer wagon.

2. The joint tipping wagon. In this wagon, as in the former, the centre of the front axle is the point around which the wagon turns, but it is higher by the depth of the lower frame, which is jointed, the front plummer block forming also a hinge between the front and back part of the lower frame. By this means the wagon is more rigid than the former, and can be conveniently locked down behind to the back axle, which serves to counterbalance the weight. The wagons are usually made deeper than the bogie wagons, containing about three cubic yards. For a long lead or a wet cutting they are the most useful of any class of tipping wagons.

3. The high-flyer wagon. This is the typical contractors' wagon, and is more generally used than any other class. It has a complete lower frame with regular tipping joints set in front, and a crossbearer behind to bring the upper frame of the wagon to the proper level. It is more easily tipped than any of the others. The upper frame being above the level of the tyre of the wheels, wagons of this construction are easily made for tipping to the side. These have in addition to the frame before described cross bearers for supporting the tipping joints, which are placed transversely. Although the hight of the sides above the rail is in this case more than in the end tipping wagon, the tail doors, which in this case are on each side, render the filling of it not more difficult than in the case of the other.

Difficulty is often experienced by contractors in tipping certain kinds of material in wet weather, and from some cuttings in all weather, owing to the adhesion of the particles to the sides and bottoms of the wagons, and many expedients are resorted to for the purpose of remedying this. Sandy clay is probably the most difficult material to work in wet cuttings. Even when filled into the wagon in a comparatively dry state, if the lead be long, it generally settles down into a hard compact mass below, and a semi-liquid state on the surface. Brushwood, loose boards, &c., have been tried in the bottoms of the wagons, with only partial success. Another method, in which a strong post was driven into the bank with a heavy chain attached with an end link for attaching to the draw-bar of the wagon was sure either to break itself or damage the frame or draw-bar of the wagon. The subject is of great importance, and we mention it in hope that some gentleman may be able to suggest a remedy. We have seen as many as fifteen wagons out of a train of thirty follow one another to the bottom of the bank in the attempt to tip them, some of them having turned over twice before any of their contents were discharged.

Piling Machinery.—This is subject on which a whole paper might be very profitably expended, but we hope with the assistance of a model of the machine at present in use on the reclamation embankment of the new Leith Dock to set before you the important practical points in this branch of contractors' work.

The peculiarity of the work as well as its position rendered a more complicated machine necessary than is usual for ordinary pile-driving. For, first, a row of sheeting piles 9 ft. long had to be driven to the surface of the ground, and at every 18 ft. a cross row of four piles 25 ft. to 27 ft. long were required for the purpose of supporting the staging on which all the materials to form the embankment had to be carried. At high water of stream tides the sand is covered to a depth of 13 ft., while at

low water the ground is dry. The engine and boiler required to be set above high-water level, and as it was inconvenient if not impracticeable in the circumstances to make a machine to run to the sand both longitudinally and transversely, it was resolved that one under frame the whole width of the staging should be made to run longitudinally on the sand with an upper frame carrying the engine and boiler to move transversely on the top for the purpose of driving the staging piles. As the machine, which has a span of 43 ft. between the lower rails, is moved along in the line of the embankment, a row of sheeting piles 9 ft. × 2 ft. × 6 in. each is driven by a ram working between two hanging leaders by means of an endless chain which is driven by a pitch wheel keyed on the end of the shaft of the steam winch. From 18 to 22 strokes per minute with an average fall of 7 ft. is about the speed attainable with this machine, and a pile 9 ft. long takes from three to four minutes in driving to the surface of the ground. At every 18 ft. in length the endless chain is slipped off the pitch wheel and the top framework carrying the steam winch and boiler is moved to the position of one of the staging piles. These are driven with a ram of the ordinary construction having a monkey with a lever worked with an ordinary chain round the barrel of the steam winch.

About eight strokes per minute is the speed of this ram, and it takes from ten to twelve minutes to drive a pile 6 ft. into the ground.

Between the ebbing and flowing of the tide is from three to four hours, nine sheeting and four staying piles being good work for one tide.

The working of the upper ram for driving the staging piles is evident and requires no description. The working of the lower ram with the endless chain is not so evident, as its working parts are concealed in the ram itself. These consist of an eccentric pully with a strap around it to which a bolt is attached by a joint. The axle of the pully has a lever attached outside the ram, to the end of which a rope is fastened for raising the eccentric and throwing the bolt into one of the open links of the pitch chain. On the front of one of the leaders a staple is fixed, which catches one of the ends of the outside lever when the ram has reached the required height. The ram instantly falls and is again thrown into gear by pulling the rope at the end of the lever.

Many forms of piling machines worked by endless chains are in use, and there is yet much room for improvement in all of them. No part of contractors' plant is subject to such deterioration or costs so much to keep it in repair.

We have so far endeavored to describe some of the common items of contractors' plant, a plant, as all contractors know, which grows very sensibly on every large work he engages, and which but for the pruning it occasionally gets at the hands of the auctioneer, would soon produce nothing but leaves. We have just been able to bring together some of the materials of which it is composed, but not to proceed to the elaboration of the sap much less to set it in motion, while the fruit—well, we hope for some fruit, for if we have been able to give you some idea of what the plant consists, and to lead your society to take an interest in the minute ramifications of its tissues, we shall consider that we have not failed in the object of our paper. An engineer's education is not complete unless he is acquainted with all the various forms of contractors' plant, and we are happy to say that some engineers, consider it indispensible to make drawings of the various machines used on their works.

Alterations in the way of working and suggestions of improvement in machinery made by engineers are generally taken by contractors in the most friendly way, and we think that modifications in the design to suit the views of an experienced contractor should be received by engineers in the same spirit. No doubt proposals of alterations are generally made for the benefit of the party proposing them, but it is not always the case, and even then, should the stability of the work not be endangered, there is no reason why the contractor should not benefit by his prudence and forethought.

A good understanding between the engineer and contractor is indespensible to the carying out of the work satisfactorily, and the more thoroughly the one understands the work of the other the easier will it be to keep matters properly balanced, and sustain that mutual confidence on which so much depends for the carying out of large undertakings.

River Protection at Plattsmouth, Neb.

A Paper read before the Boston Society of Civil Engineers, March 15th, 1876. By Thomas Doane, C. E.

The easterly terminus of the Burlington & Missouri River Railroad in Nebraska is at Plattsmouth on the westerly bank of the Missouri River.

The city of Plattsmouth lies upon and among the bluffs of this river about two miles below the mouth of the Nebraska, or Great Platte River.

This river descends from the west, with a fall of from three to five feet per mile, and discharges the Rocky Mountain waters into the Missouri River, through several mouths. These mouths are very changeable as to location and capacity, and the river is apparently very whimsical as to the particular mouth or mouths which at different times and occasions it selects through which to discharge itself. Its waters are white and at times strikingly in contrast with those of the Great Muddy, and the two waters can be traced for miles before becoming so mixed as to lose their identity.

Freshet time of the Platte River is usually in April, while that of the Missouri, whose sources are much further north in the Rocky Mountains, is in June. If the Platte River in freshet, finds the Missouri at a low stage, it projects its waters entirely across the Missouri; while in cases of local freshets, in which either river may obtain the ascendency, the current takes other courses, and as a consequence keeps the Missouri channels, sand bars, and banks in a very unsettled and unsatisfactory condition for miles below Plattsmouth.

The station grounds of the rail-road lie along the river under the bluffs, between the city of Plattsmouth and the river.

Within ten or twelve years there was a broad meadow bottom extending along the front of the city, having a width from the bluffs of nearly half a mile, but an important change in the Missouri itself, combined with the action of the Platte, has taken this all away, and the river was only restrained by the harder material of which the bluffs are made up.

The Missouri at this point is now from a mile to a mile and a half wide, while the Platte for two hundred miles above its mouth is from half a mile to a mile wide. In consequence of this washing away of the table lands, and the very crooked condition in which the banks were left, it was found that suitable grounds for the rail-road could not be had without reclaiming something from the river, or at least substantially protecting what remained.

The problem was, *how to do it*. The conditions were a ledge of rock in the bluff about two miles *below* the station, a *river* in front having a depth at low water of twenty feet, a current of *four to five miles per hour*, running *straight* against the bank to be protected, and carrying ¼ inch of *sand* in a *tumbler full* of its water, equal to one of sand to twelve of water while in freshet.

It was determined to push out boldly into the river, in order both to reach the *hard bottom* of the *river*, and so save being undermined, and to *secure* an even width of grounds between the river and the bluffs, thus accomodating several parallel rail-road tracks. The line desired was first laid out and soundings were taken along it, giving an extreme depth of twenty feet without material variation. A part of the line was a regular curve, and a part straight.

A steamboat and a couple of 120-ton barges were bought. Upon the boat a pile-driving machine was set up, and along the located line, piles were driven at a distance of ninety feet apart, this being the length of the straight side of the barges. The quarry men were then set at work and large loads of stone were towed from the quarry to the place where the piles were driven. The barges were moored to the piles and the stone were discharged into the water. This was repeated till the stone just appeared at the surface of the water. The piles were all numbered and a record of stone discharged between two adjoining piles was kept, through the whole length of the work. Every other space betwen the piles was omitted in discharging stone, that is only one half the spaces, and consequently only one half the whole length was filled with stone. The numbering of the piles was necessary, not only to determine the amount of stone put in between any two piles, but to ensure the leaving out of stone in the spaces not to be filled.

All this work was done in the spring, and before the occurrence of the June freshet in the Missouri.

It was expected that the heavy current of the river would be restrained by the winrows of stone lying along in line, and that the water running inside between the stone and the banks of the river, would be so retarded as to deposit a considerable portion of its load of sand. The freshet of course overtopped the stone which only reached up to low water level, and so continually provided other waters to dump their new loads of sand. So the work went on perpetually day and night, seven days in the week. After a month or two the freshet subsided, and the whole space *behind the stone*, and up to a *level* with the top of the stones, and also out to a slope in the intervals, even with the outer slopes of the winrows, and among the stone too, was found well and honestly puddled full and tight with sand. The common freshet-height of the Platte River is but about four feet, and it rarely overtops its banks, the great fall in the river making it impossible. That of the Missouri River is about ten feet, while its great freshets reach twenty feet.

Having accomplished so much by the help of the boat and river it now became necessary to abandon the boats and barges which could not work in freshet times and which could not well elevate stone above low water level. A rail road track was now laid upon the sand, and a narrow embankment was raised up to near high water of common freshets. The outside of this was then covered three or four feet thick with stone, having the outer face on the same slope with the stone before discharged into the water, and wherever the slopes in the intervals between the original winrows would take stone they were covered so as to make a uniform face upon the river side. The work was then subjected to another freshet, and all was then filled behind the stone up to its top with river sand.

The economies of this process are the following: While an attempt to fill into the river with earth and then to face with stone would have been entirely unsuccessful, because the earth would be carried away as fast as put in, this process secured the whole of the filling without cost except of time, and of this only about fifteen months.

If an embankment of stone had first been raised to high water mark, the depth at low water being twenty feet, and freshet height ten feet more, with slopes of one and a half to one, there would have been consumed fifty cubic yards of stone per lineal foot. By this process the *maximum* quantity of stone used was but twenty-four cubic yards per lineal foot; and by filling with stone for only one-half of the total length, the *average quantity* of stone used was but twelve cubic yards per lineal foot.

The natural banks of a river, having a height of thirty feet from the bottom, may be rip-rapped seven feet thick with about eight cubic yards of stone per lineal foot, which is a saving of but one-third of the above. The advantages of the process which has been described, over the rip-rapping process, are that land can be reclaimed from the river by the first process, while it cannot under the second.

That the meanderings of the river bank, giving increased length to rip rap, can be reduced to such shapes and lines as may be desired for convenient and economical use.

That the work thus becomes permanent, because much less liable to undermine, and much more sightly because irregularity is reduced to regular curves and to straight lines.

In doing the work above described, it became necessary of course to join the winrows of stone at the upper end to the river bank, in order to prevent a draught of water down behind the stone, for then there would have been no deposition of sand. It is very possible that longer intervals between the winrows of stone might have been left, especially in that part which was straight. To fill every third space would probably have been sufficient in that case.

The distance filled in this case had a length of about half a mile, and a width of from twenty to one hundred feet. The upper half of the length was on a two-degree curve about, and the lower part was straight. It was intended to make a future extension by going further into the river, and around a heavy concave bend in the river, and the lines were laid with reference to this. It is not uncommon to call in the aid of such a river to fill behind stone embankments previously made, but it is not known that intervals have been left in the stone embankments whereby as good work is secured at a great saving of cost.

To calculate how fast such work can be filled with sand, when the river runs five miles an hour, and a tumbler full of surface water carries one-quarter inch of sand would be a difficult problem to solve, but when such water so ladened, loses a portion of its velocity, the filling goes on with remarkable rapidity.

TECHNICAL EDUCATION.

Perhaps there is no subject of such vital importance to the engineering profession as that of technical education. Less than two years since this subject was brought before the American Society of Civil Engineers by some of the representatives of our technical schools and referred to a committee who reported back that it was a subject to be best decided by the schools themselves and the results of their competition. This was certainly evading the question and could not help the schools in their laudable desire to improve their courses of instruction.

It was very gratifying to learn that the Joint Meeting of Civil and Mining Engineers had set apart a day for the discussion of this subject at their annual meeting this year at Philadelphia. Two days, the 19th and 20th of June, were spent in this discussion, during which about twenty-five papers were presented. In our report (No 26) the leading ideas of many of the papers are given, and when the papers are published in full, in pamphlet form, they will constitute the best contributions yet offered to the literature of the subject. The thoughts of such men as Dr. Raymond, Thos. C, Clarke, Coleman Sellers, W. Milnor Rogert, Ashbel Welch, Prof. Roberts and A. L Holley, together with such distinguished foreign visitors as Capt. Douglas Dalton of London, and Dr. Wedding of Berlin, all men of acknowledged ability and weight in their several professions, must have its influence in moulding the future of engineering education.

In the absence of the actual papers it is impossible to sum up closely the results of their deliberations, but while they seem far from agreeing in all particulars, on some general points there was a remarkable unanimity of opinion. Almost every speaker agreed that the results of experience shows the value of a broad foundation of general culture as a basis for technical training. All were agreed on the necessity of practice before, during or after, the theoretical course, although there was a considerable difference of opinion as to the proper time to introduce this practical training. It was also generally admitted that it was unwise and unjust to confer degrees on graduation.

With these general conclusions we aae in most thorough accord.

We remember a saying of Dr. Davies, formerly of West Point, that a student who came to his classes with a good classical preparation could learn more mathematics in two years than another, without such preparation, could in four. This is probably true of all technical courses, and it makes very little difference whether the preliminary training is classical or otherwise provided the discipline is there, although that peculiar drill in close habits of observation which one gets in the study of natural history, and the accuracy and sharpness of thought and scientific training of the imagination which one gets in descriptive geometry and kindred studies, seem the best preliminary to technical courses. We are not marking out a course of training, but only mention these two subjects as most directly contributing to the habits of thought of an engineer.

It is a subject of great interest, especially in this western country where most people call a man who can run a line by needle an engineer, and where every county or town surveyor hitches C. E. to his name, nails up a shingle, and armed with a Trautwine, is prepared to design anything from a highway fence or a tile drain, up to a bridge of a 1000 feet span, or a sewer system or water works, etc.

What is worse, the western college has tacked on an engineering course, run by one man power, and however good he may be, it is utterly impossible for him in four years, the largest part of which is devoted to general subjects, to give more than the most superficial training,and yet the fledglings are sent forth with a mammoth C. E. which is the most conspicious part ot them. We remember a case of a college of some note in which the Prof. of Engineering labored for two years to convince the faculty that a little land surveying and railway work, coupled with a course in bridges, with no more mechanics to back it than can be found in an elementary work on physics, did not constitute a course in Civil Engineering. It seems a disgrace to the profession that such things can be.

We believe, that in the profession of law, a man is obliged to be admitted to the bar by a judge of the court in which he intends to practice. But doctors and engineers can hitch titles behind their names and stick out a shingle anywhere. The same is true of architects, not half of whom know enough to calculate the strains in a roof. A case in point is the roof of Memorial Hall at Philadelphia, which had to be strengthened to prevent its falling and becoming a total wreck.

Without saying more we would advocate that such societies as the American Society of Civil Engineers should give degrees or admit a man to practice, in a manner similar tq admittance to the bar in law practice, and that such a sentiment shall be created that no man shall be able to practice, except in a subordinate position, who has not the proper trade mark. At the same time we should make the engineer responsible for the character of his works. Let the engineering schools give some minor degree if they desire, but like the law schools let their graduates stand the test of examination by men who have achieved something like a reputation in their profession.

A SECOND French canal scheme, which we omitted to mention in our last issue, is being quite seriously taken up, the Ministers of Finance and Public Works having the project under consideration. The canal is to be sufficiently large for vessels of 250 and 300 tons. The route is by the Seine, the old Burgundy canal and the Rhone, and will save about 1000 miles of navigation to all heavy articles of freight, to which class of traffic it will most probably be confined. The depth will be 13.5 metres on the Rhone and 2 metres elsewhere. The locks will be 133 metres by 12 metres. The estimated cost is 65,000,000 francs; 10,000,000 francs on the lower Seine, 5,000,000 on the upper Seine and Yonne, 10,000,000 on the Burgundy canal, and 40,000,000 on the Rhone. The works can be completed in six years and it is believed will retain in France much traffic which is likely to pass via Austria on the completion of the St. Gothard Tunnel.

MR. PULLMAN seems to have met with considerable success in introducing his coaches in England. It is now about two years since he introduced them on the Midland Railway, and the discussion that took place in English papers was very interesting to Americans. We learn from *Engineering* that this company has twenty-five Pullman cars in operation, and th at the double bogie system has met with such favor that bogie trucks of four wheels and even six wheels, as used here, are coming into quite general favor for passenger traffic Forty-four carriages mounted on six wheel bogies are now being built for the Midland, the designs of the bodies being modified to suit the special requirements of English traffic. Full as much dead weight is put into these carriages as into our own Pullman cars. English engineers are much more inclined than formerly to go out of their own country for a good idea. However, they never adopt an idea without attempting to modify it, as was illustrated by the adoption of the Westinghouse air brake; it giving rise to a score or more devices for accomplishing the same object, each, however, inferior to its prototype.

The day is certainly past when everything *non-insular* is unworthy of notice.

THE waters of lake Michigan usually stand about two feet (average 1.83 feet) above datum. During the first part of the present month they have risen to a height of 3.4 feet above datum, a height unknown during the past 19 years and only exceeded in 1857.

The people of Grand Crossing and South Chicago are much exercised about it,as in many portions of the town the land is but 1½ to 3 feet above the present surface of the lake. Various plans are recommended for relief. among which is a canal forty feet wide and six or eight feet deep, extending from the Calumet River near the railway bridge, two miles, to the vicinity of Cottage Grove Ridge. We do not desire any corner lots in that vicinity at present.

WE learn from the *Railway World*, that Senator Jones and his associates propose to build a road from Los Angelos, Southern California, to Ogden, Utah a a distanee of 686 miles. The road form Los Angelos to the Port of Santa Mornica, 16 miles, is now in operation and will be the outlet of the proposed line to the Pacific. This route is shorter by 250 miles, than from Ogden to the Pacific by the Central Pacific Railroad. From Los Angelos two routes have been surveyed to connect with the Utah Southern Railway, the most direct of which runs as straight as possible to Cajon Pass, thence via Camp Cody and the Old Salt Lake wagon road, via Pioche, to the drainage of the Rio Virgin near St. George, in Southern Utah; thence north to a connexion with the Utah Southern Railway at Nephi, its presentt terminus The Utah Southern is now constructed 130 miles south from Ogden, and will be pushed to the Colorado River in order to reach the coal and iron fields of SouthernUtah.

AN engineer in Hartford, Conn., has obtained a patent upon an invention of his own which he calls a feed-water indicator. It is designed to be applied to steam boilers, either stationary or movable, and its use is to show whether the feed pump is working properly and forcing a current of water into the boiler. It is inserted in the feed-water pipe between the pump and check-valve, and any failure of the water supply is promptly noted. Connected with it is an arrangement to be used in locomotives, by which the engine driver can readily see by the dial in the cab whether or not his pumps are working, whereas he now has no assurance that the pet-cocks, when closed, have not stopped. This instrument, if it proves to be all that the inventor thinks it, will do much to lessen the liability of explosions.

THE SUCCESS of the Boston, Revere Beach and Lynn Railroad has startled into life numerous schemes for shorter or longer narrow-gauge lines to radiate from Boston in all directions, No very careful calculations of probable receipts seems to be made; yet, in many cases, the proprietors will come into competion with the old established roads, they can but reasonably expect to carry but little freight, they will have heavy land damages to meet, and will find that a suitable terminal station in Boston can be obtained only at a great expense. They talk of carrying transient passengers for one cent per mile, and of selling season tickets at the rate of one-half cent per mile. The suburbs are thickly settled, and low fares will attract custom, but a road must be built very inexpensively to pay at those figures. The plans to which we refer, are set forth by the Narrow-Gauge League and Construction Company, and the matter is to be thoroughly agitated in each town.

IT IS proposed to build a net work of narrow-guage railways from Boston to many of the principal towns between that city and Worcester and Fitchburg. The difficulty of entering Boston without cost, is proposed to be met, by a pile bridge over Charles River and a tunnel under Beach Hill, coming out on Pemberton Square, or Washington street,near the old South Church. As the tunnel will run below buildings and sewers, the land damages are reckoned at a small figure, and a basement of a large building will be used as a depot. This portion of the scheme reminds one of the Metropolitan Railway of London. The Newton and Boston narrow-gauge line has been surveyed through Brighton and Newton to East Natick. Another proposed line is the Boston, Watertown and Waltham, with a branch to Cambridge. Movements are said to be making to finish the Massachusetts Central as a narrow-gauge to West Boylston, and lay another rail thence over the Nashua Railroad to Worcester. From Boston on the Central it is proposed to lay a third rail over the Boston, Clinton and Fitchburg R. R. to the latter city. Then another line is proposed, from the west end of the tunnel and Charles River, through Brighton, Newton, Wellesley, Natick, Framingham, Ashland, Southboro and Westboro to Worcester. The freight depot would be located on the low land outside of Boston. These schemes are sufficiently comprehensive, and it remains to be seen how they will be practically considered by the committee interested.

THE *American Cabinet Maker* gives some directions, as follows, for the sharpening of edged tools: "The grindstone should not be less than two feet or eighteen inches in diameter. It should revolve to meet the tool (except when grinding very fine or delicate tools). In grinding a chisel, for instance, it should be held firmly on the stone without moving, until a slight wire edge is felt on the other side which may easily be told by

passing the thumb over the opposite side to that which is being ground. When this is felt, turn the chisel over, and proceed in the same manner until the wire edge is transferred to the opposite side. It should now be whetted on an oil stone, taking care to hold the tool upright, It should be whetted, first on one side and then on the other until the wire edge appears off; now take a piece of deal, free from grit, and draw the edge of the tool across the grain; if it has been properly whetted the wire edge will now be properly removed. Gouges are only ground on their convex surfaces. They should be ground until a wire edge can be felt by passing the finger along the inside of the gouge. This can be removed with the oilstone and deal. While grinding gouges they should be constantly turned from right to left, or the edge will be full of notches. Tools for soft wood should have a long bevel edge to make them cut keen. About a half inch bevel is best."

THE "Treaty of Washington" allowed mutual navigation to American and Canadian boats of certain rivers and canals bordering the lakes. Our Government has refused admission to Canadian tugs on certain rivers, especially in the case of tugs ladened with lumber going below Albany. The Canadian government, after protesting, has issued retaliatory orders not to admit American tug boats into the Richelieu and Ottowa rivers. The Canadian papers also advocate closing the Chambly locks to our canal boats. It is hoped that the existing complications will be adjusted during the present business stagnation as they would be very embarrassing on a revival of trade.

AT a late meeting of the Physical and Natural History Society of Geneva, M. Turrettini, who has to make frequent visits to the boring of the St. Gothard tunnel, gave an account of a phenomenon which is often produced in the granitic mass of the mountain. When the rock is shaken by the explosion of a mine the report is followed, at unequal intervals, by other spontaneous explosions at considerable distance from the charge, of which the cause is unkown, and which are attended with serious results to the workmen, The phenomena is new, and appears to indicate a kind of tension inherent to the formation of granite, which, when agitated at one point, is transmitted to a distance so as suddenly to disengage large fragments of material. It may be compared with the experiment daily made by the quarrymen who work the erratic blocks in the valleys of the Alps to obtain building materials. They use wedges of wood, which they drive into holes drilled for the purpose, and which being wetted, cause, by their expansion the disjunction of the granitic masses. This rupture is always accompanied by an explosion more or less violent, and the two surfaces cannot again be exactly fitted to each other. A deformation of the material occurs, leading to the presumption of a state of tension existing in the constitution of the rock itself.

M. MAGNON has been investigating the transmission of power to long distance by means of an electric current transmitted along a wire or cable. He proposes to employ a Gramme magneto-electric machine which transforms the mechanical force into electricity, and again a second machine used in an inverse manner to reconvert the electric current into mechanical force. It is asserted by M. Magnon that this can be done with less mechanical loss than by any other method of transmission. If this be so the transmission of power to long distances will become, comparatively, an easy process and it will be no longer necessary to place large manufacturing establishments near a water privilege or other source of power.

The Meteor.

A meteor of extraordinary brilliancy passed over this region last Saturday night, and it is due the scientific world, that the facts, so far as ascertained, should be put on record. We saw it at Evanston, 12 miles north of Chicago, on the lake shore. It first appeared nearly due east, at about 8:45 P. M. from 25° to 30° above the horizon, and took a course about 40° N. of west about 25° from the zenith, and disappeared at about 50° above the horizon.

It gradually grew brighter as it ascended, until in the middle of its course it appeared as brilliant as a magnesium light, which it much resembled in character, and again faded out very much as a rocket in the upper part of its course. No explosion or noise of any kind was noticed. It appeared about the size of a man's hat, and a train as brilliant as the meteor itself was observed throughout its whole course for some 20 seconds. Through the central part of its course, occupying about 40°, the train gradually faded away as it broadened and divided into patches of nebulous light of an aurora like color, lasting nearly 20 minutes.

The illumination of surrounding objects was very brilliant and ghastly. We learn from our exchanges that the same meteor passed over Marshall, Mich., at 8:45, about 30° north of west; path serpentine, just before disappearing; smoke visible 15 minutes.

It passed over Joliet, Ill. from S. E. to N. W,; also over Oregon, Ill., where it was observed to explode when apparently on the ascent. It was seen at Battle Creek, Mich., appearing in the constellation of *Ophiucus*, describing a semicircle to the southwest, where it burst with a report, about 10° above the horizon near the constellation of *Leo*. It passed over St. Joseph, Mich., and disappeared suddenly over the lake without explosion. At Valparaiso, Ind., it appeared at a point a little N. of E., 55° or 60° above the horizon, for a distance of about 40°, in a direction a little N. of W.. At Clinton, Iowa, it was seen in the east moving nearly paralell to the horizon. At Indianapolis Ind., it was seen among the stars of *Cassiopeia*, low down, a little east of north. At Chicago it appeared about 25° above the horizon near the head of the *Dolphin*, a little to the S. of E., passing upward to near *Gamma* in the *Swan*, and disappearing at an altitude of about 59°, a little to the N. of E.

Mr. C. W. Irish of Iowa City, Ia., send us the following description.

Dear Sir.—On Saturday the 8th., at about 8 o'clock in the evening, a large and beautiful meteor was seen, about *due east* from here, altitude, about 30° or 35° and motion from right to left and downward. The trail was light for some minutes after the meteor disappeared.

All the accounts agree as to its unusual brilliancy and the remarkable persistency of its train as seen at Evanston, but there is some discrepancy in regard to the other evidence.

Prof. Colbert of the *Tribune* staff, to whose article in the *Tribune* of July 13th, we are indebted for part of our notes, gives a summary in which he says the meteor was visible as far east as Toledo, and the object passed on a line very nearly through Berrien, Mich., trending several degrees to the N. of W. Its nearest approach to the earth was not less than 60 nor more than 70 miles. The main body of the object undoubtedly passed on in its journey through space although the intense heat generated in passing through our atmosphere caused partial disintegration, the falling fragments being mistaken for an explosion, which it was in one sense of the term. Shining by reflected light alone, the object must have been 50 yards in diameter but brilliantly incandescent as it was, the object was at least a yard in diameter and probably much more. We give the following extract from his article as of general interest.

"Our visitor of last Saturday is only one of many millions which pay us their respects yearly. A little larger than the average, inasmuch as they do not average more than a few grains each, while this Triton among the minnows may contain several tons of matter; but one of the class notwithstanding. Many of them fall to the earth and have thenceforward no individual existence. The others haul off, after a narrow escape from collision with our planet, and travel on as before.

Not so either. Take this mass as a sample of the rest. It was coursing about the sun in an orbit of its own. Traveling at a rate of not less than 18 nor more than about 25 miles per second, it came near the earth's orbit at a time when the earth was near the point of intersection of the two orbits. Traveling in nearly an opposite direction the little wanderer rushed into the upper regions of the earth's atmosphere with a relative speed of some 40 miles per second. Two sets of altered conditions were the necessary consequence. Its flight was impeded, and its velocity diminished by the impact, while the attraction of the earth drew it "downward" from the path it would otherwise have pursued. A few miles nearer to coincidence of path, and the earth's attaction would have been powerful enough to absorb the wanderer to her bosom. As it is the original orbit is destroyed beyond repair; the little planet being sent off in a new direction into space, with an altered axis of revolution, and a different period around the sun. But the concussion with our atmosphere has wrought many other changes, affecting the integrity of the mass itself. From being a cold body, chilled nearly to the temperature of the interplanetary spaces, it became heated by air friction to a temperature more than 2,000 degrees, and thus became so luminous as to be visible to us. The air through which it passed also became so intensely heated as to be self-luminous after the little planet had left the neighborhood of the incandescent air. The mass itself, after having lost a portion of its exterior by the unequal expansion due to so sudden a change of temperature, passed out into space, probably cooled down far below the artificial zero of temperature.

The luminosity of the path of the meteor was largely due to the incandescence of the particles which were stripped off in the passage through the upper air. Their light was visible for many minutes, and the apparent position of the track changed in the sky by the slow sinking of these incandescent particles, combined with the fact that the rotation of the earth carried them away from the stars in the background of the ethereal vault beyond.

Newport, R. I., Water Supply.

The city of Newport, R. I., has granted to Mr. Geo. H. Norman the exclusive right of constructing waterworks in said city, for the supply of water for domestic and public use for the term of fifty years, and has voted to him all its rights in Easton's pond and in its land around said pond. The works are to cost not less than six hundred thousand dollars, and are to be begun within six months. Mr. Norman is to build the water-works, lay the pipes, etc., at his own expense, the city to exempt them from taxation for fifty years, he, of course, to have the revenue from the water rates. Mr. Norman is a native of Newport, and owns one of the finest estates in the place. He is willing to sell the property to the city at any time after five years, at a fair rate, and guarantees to furnish the water at rates which will compare favorably with those charged in other New England cities.

"A CALL FOR FAIR PLAY."

Written for Engineering News.

BY J. A HAYWOOD, C. E.

In your issue of June 17th, 1876, you published an article entitled, "A Call for Fair Play," credited to the *Detroit Free Press*. In this article there are some statements which although not absolutely false, are so artfully made that they tend to mislead and prejudice the casual reader.

It is now considerably more than a year since Mr. Eads commenced his jetty work at South Pass, Mississippi River. Failing to accomplish his work as fast or as successfully as he had promised, he began to attack several officers of the United States Engineer Corps, declaring that their opposition prevented the success of his plans. I would like to know how the opinion of any man, whether a private citizen or an army officer, would in any way affect the success of the jetties, when Mr. Eads has indisputable power to use any means he may see fit to secure the necessary depth of water at South Pass.

There is but one way in which it can affect the work and that is, as mentioned in the above article, to prevent people from investing capital in a dubious enterprise. If, now, men in a position to judge, firmly believe that any great enterprise involving millions of private capital would certainly prove a failure, would it be right for them to stand back and say nothing, thereby silently assenting to the experiment, and inducing hundreds of men to invest capital, absolutely certain to be lost? Certainly not! and Gen. Humphreys and Major Howell, in making their opinions known to the world and showing people why jetties cannot, in their opinion, succeed, are doing no more than justice demands.

Between the years of 1850 and 1860, Gen. Humphreys, personally, made a series of surveys which included

the delta of the Mississippi, the result of which may be found in that most valuable work, "Humphreys and Abbott's Report on the Hydraulics of the Mississippi, River," Since the close of the war, a series of surveys have been continued from year to year, which, in completeness and accuracy cannot be excelled. The compiled results of these surveys give rise to facts which are indisputable, and which show conclusively that the failure of any system of jetties to bring deep water to South Pass, or any other pass at the mouth of the Mississippi River, is merely a question of time.

In your issue of June 24th (page 204, Vol. 3) in an article credited to *The Nation*, the statement is made that Mr. Eads "has become involved in an unfortunate and unnecessary dispute with Major Howell of the United States Engineers." In reply to numerous published letters and articles attacking his private character and his exercise of duty as a public officer, Major Howell has published but one reply. That appeared in the *N. O. Republican*, about the 1st of June, and was a refutation of the charges against him. In this letter he showed conclusively that the actual depth of water through South Pass jetties has been misrepresented by Mr. Eads, and that the rate of advance of the bar at South Pass during the past year has been many times greater than its normal rate of advance as determined by observations extending back for several years.

Major Howell is a man whose reliability of statement cannot be impeached, and any statement made by him can be implicitly relied upon. In justice to him and in accordance with the demand for "Fair Play" issued by ENGINEERING NEWS, I trust you will place this communication before the numerous readers of the columns of your valuable paper.

NEW ORLEANS, July 3d, 1876.

Personal.

We were pleased to receive a call this week from Mr. Ernest Pontzen, C. E., Member of the Austrian Commission to the Centennial.

NOTES.

Saginaw, Mich., has 4¾ miles of public sewers.

London has 686½ miles of constant service water mains.

Lawrence county, Ohio, furnaces made 43,157 tons of pig iron last year.

The copper mines of Newfoundland are being developed with great success, and large deposits of lead have been discovered.

54,000,000 gallons of water was pumped at the Chicago water-works one day last week. We believe this is the greatest quantity ever pumped in one day in this city.

Statisticians estimate that there are now at work 500,000 steam engines, with a total power of 12,000,000 horses, corresponding to the muscular strength of 100,000,000 men.

The Central Pacific Railway Company have built over 200 miles of tracks this year at an average cost of $30,000 per mile, giving a total expenditure of $6,000,000 for the construction of the year.

Newport, R. I., is so happy over the prospect of having a public water supply, that when the acceptance of the recent proposition of Mr. Norman was made known, the bells were rung, the firemen paraded, and guns fired.

Iron water pipes lined with glass, for domestic supply, have been used in several houses in New York and are very highly spoken of. The danger from the use of lead pipes or the various combinations of lead and zinc, or lead and tin, is entirely obviated.

The *New York Tribune* is authority for the statement, as coming from Gen. John Newton, that the explosion at Hallett's Point will not take place until Sept. 1st. The excavation has been completed for some time but the contract for explosives is not yet closed.

The last brick is laid in the Hoosac Tunnel. The State Railway Officials have ordered steel rails for the whole distance between Greenfield and Bradwell's Ferry. Arrangements have been made for the running of through trains from Boston to Troy, Albany and Saratoga.

The Union Canal extends from Middletown, on the Susquehanna, to Reading, on the Schuylkill, seventy-nine miles. It was suggested by William Penn, in 1690, surveyed by David Rittenhouse, commenced in 1764, finished in 1837, when the first boat passed through it.

The new water-works in Athol, Mass., are well under way. The large reservoir, to cover about sixteen acres, is nearly cleared of brush and trees. The lower reservoir, for supplying the Lower Village, contains two acres, and will give 300 feet head. The main pipes will range from 12 to 4 inches in diameter.

We gather from the official report of the St. Gothard Tunnel that the monthly progress at the northern end is 380 feet; and at the southern end, 200 feet. 20,000 feet are completed, about 10,000 feet at each end; 50,000 feet remain and at the present rate of progress (about 600 feet per month) the tunnel will be completed in about seven years.

One hundred and sixteen men have been discharged at the Springfield, Mass., armory, proportioned among the various departments as follows, Water shops, 32; machine shops, 14; milling shop, 28; filling shop, 37; stocking shop, 5. Work is expected to start up at the institution about the 17th, when the daily production of muskets will be reduced nearly one-half.

Six, 100-ton guns are now being constructed by Sir W. G. Armstrong for the Italian navy. The guns will be constructed of steel coils shrunk about a steel tube. The length will be over 30 feet and the diameter of the trunnion coil 6¾ feet while the bore is 15⅝ inches; they are loaded at the muzzle. Owing to their unprecedented size and weight special plant has been devised for their manufacture.

The city of Eau Claire, Wis., voted on the 11th inst. to donate to the Eau Claire Dells Improvement Company $100,000 to build a dam at the Chippewa Dells. For the past fifteen years the Dells bill has taken up a large part of the time of the Wisconsin legislature, and was finally settled last winter. The engineer's estimate of the cost is about $140,000. The total cost of the works, with the necessary land, etc., will be $300,000. It is expected that the city of Chippewa Falls, which has opposed the measure thus far, will have an injunction issued restricting the council from issuing the bonds of the city, and that the supreme court will have to decide upon the legality of the bill before work can be begun.

A special dispatch to the *Tribune* of July 6th says that in a week from this date the first locomotive to be employed on the Canadian Pacific Railway will be running at Thunder Bay. Some twenty-five miles of the road are ready for the rails that are on the spot, and nothing now stands in the way of a speedy final construction of the whole sixty miles of the road between Thunder Bay and La des Mille Lacs, thence to Rat Portage, from which point to the Red River the railway will come into service again. There will be temporary communication by water with Pembina during the construction of the line between Rat Portage and La des Mille Lacs.

The workmen employed by Capt. Eads, on the Mississippi river jetties live in huts in a canebrake swamp, and every rise of the tide covers the ground with water. They also endure the bites of unusually large mosquitoes and the proximity of alligators. The streets of Port Eads, as the village is called, are planks laid on posts. The jetties are built of willow matting, alternated by layers of stones. The willows are obtained on an island near by, the supply being equal to the immense demand. On the bank of the island is a sloping platform, upon which the mats are made by laying the willows crosswise and lengthwise until the mass is thirty inches thick. Strips of wood, firmly bolted, hold the mat together after it is pressed compactly. Then it is launched, towed to the spot where it is to be used, attached to guide posts, and piled with stones until it sinks. Each mat is a hundred feet long and from fifty to fifteen feet wide, according to the place it is made to occupy in the tapering jetty.

In Carlisle, England, the death rate now is 11 per 1,000—as the result of sanitary safe-guards and systematic supervision. If such exemption be possible there, why not elsewhere or everywhere?

Railroad News.

Colorado starts out on her career as a State with 660 miles of railroad, all of them centering in Denver. Seven years ago not a rail had been put down nor even a survey made.

The work of substituting the wooden bridges on the line of the Boston and Albany railroad with more substantial structures of stone or iron, is progressing favorably on the eastern division. The labor which would interfere with the running of trains is performed on Sunday, and a wrecking train runs out from this city every Sabbath loaded with workmen and tools.

The laying of the rails on the first divison of the St. Louis, Bloomfield & Louisville narrow-guage railroad was completed on the 1st inst and trains are now running over this division from Switz City, Greene Co., to Bedford Lawrence Co., Indiana, a distance of thirty-five miles. It is expected to complete the road this season, to a distance of sixty-five miles west of Switz City.

Articles of incorporation of the Knightsville & Chicago Railroad Company, with a capital stock of $150,000 have been filed with the Secretary of State of Indiana. The proposed line extends from Knightsville, Clay county, to some convenient point of intersection with the Zionsville, Terre Haute & Chicago Railroad, in the county of Vigo.—*Railway World.*

Mr. Henry Meiggs has submitted to the Peruvian Government a proposition for a new contract. He offers to build, in three years from the date of contract the unfinished section of the Lima & Oroya road to the Oroya, and further to extend it from that point to the great silver mines of Cerro de Pasco; also to build a tunnel which shall drain those mines very much below the present drainage tunnel, which now limits the working. In return he asks to receive, according to Peruvian mining law, the right to the body of ore between the present lowest tunnel at Cerro de Pasco and the proposed new tunnel, also the right to enter and possess the abandoned and worked out mines there and such new ones as have been and may be discovered on the line of the Oroya Railroad and its proposed extension.—*Railroad Gazette.*

The Dayton & Southeastern Railroad was chartered in 1871, and was intended to be a standard-gauge road Owing to the times, and scarcity of money, it was deemed advisable to build a road of three feet gauge. The *Railway World* has the following: "One of the features of the narrow-gauge, as was demonstrated by practical experience, is the low cost of construction. Phelps, King & Co. actually agreed and are now building this road beginning from Dayton, thence to Xenia, Washington Court House, Chillicothe to Jackson, Ohio, a distance of 114 miles in length, for six thousand five hundred dollars per mile. This amount includes grading, ties, iron rail, and laying the track for the rolling stock. The rolling stock, including passenger trains, can be put on for six thousand per mile, making an investment of twelve thousand five hundred per mile fully equipped. The narrow-gauge will carry all that will ever be required of it for a local road."

Through the liberality of the Reading Railroad Company the thousands of coal miners employed by it are having an opportunity of seeing the Exhibition at very small cost. A series of excursions has been organized, starting from different points in the Schuylkill region. The first party arrived in Philadelphia on Friday morning of last week, and the second, bringing 1,200 passengers from Girardville, Shenandoah, and adjacent collieries, came on Saturday. The third, starting from the Mahanoy region, came on Tuesday last. Each day this week there will be an excursion. The intention of the officers of the company is to give every miner and every miner's wife and children, a chance to see the wonders of the Fair.

Work on the narrow-gauge road from Columbus, Nebraska, to the Black Hills, has already been commenced. The gauge is to be three feet six inches.

For the first time in its history, the Chicago, Burlington and Quincy Railroad has been obliged to cut its passenger rate between Quincy and Chicago. This has been brought about by a war which is going on between it and the Toledo, Peoria and Warsaw Railroad.

Coal Washing in Illinois.

Paper read by E. D. Meier, M. E., before the Engineers' Club of St. Louis, Mo., June 10, 1876.

Although "*practical*" men had tried to coke Illinois coals, from mines in the vicinity of Belleville and further East, and declared against its possibility on account of the presence of agents and circumstances alike unknown to chemical and engineering science, the knowledge of the success met with by certain "*benighted*," and we must suppose—"*not practical*" men in Belgium, Germany and Bohemia, in washing or concentrating impure coals and then coking them, induced several capitalists of St. Louis to embark in an enterprise of this nature early in 1870.

Sundry specimens of lump and nut coal from mines on the Pittsburg Railroad were sent to Cologne, Germany, there ground and sized, then washed on the Osterspey Jig and afterwards coked at the Gas Works there. The gas was found to be very good, and the coke sufficiently pure for blast or cupola furnace use.

The sizing had been perfect and the washing double in each case.

The results averaged as follows:

Lump coal, crushed, { 13.94 per cent. ash, 4.4 per cent. sulphur } Washed 6½ per cent. ash
Nut coal 15.57 per cent. ash }

with a loss of from 35 to 40 per cent. in washing. The coke from this averaged 10 per cent. ash and 1.02 per cent. sulphur, and showed a coking loss of 40 per cent. This quantity, 60 to 65 per cent. of washed coal out of the crude mass, was considered possible only when arrangements were made for re-crushing and then re-washing the middlings. The consumption of water was not given. Nearly 25 per cent. of all the sulphur was found to be in the dust under 0.04 inch.

Five analyses of as many different kinds of coke much used in Iron Smelting in Westphalia were added, running from 9.8 per cent. to 12.7 per cent. ash and 1.3 per cent. to 2 19 per cent. sulphur and the desirable limits for good coke given as 12 per cent. ash and 1.75 per cent. sulphur which is somewhat lower in ash but higher in sulphur than the average of the Ohio river cokes coming to the market.

An expert was summoned from Germany who put up washing works and ovens, the machinery being largely imported from there. Unfortunately his knowledge of coal washing was merely practical, and having no scientific knowledge of the subject he naturally followed Westphalian precedents without making any allowances for the great differences between the German coals and ours in chemical constitution and mechanical structure. A second superintendent achieved but little better success and in 1872 Mr. J. W. Meier and the writer were called in as consulting engineers, and in 1873 took charge of the works.

We found no records of any determinations of specific gravity, chemical assays, or even mechanical separation of the crude coal into its component parts. A few ash tests soon showed that the washing was very imperfect and irregular, the washed coal averaging as high as 13.35 per cent. ash.

In the consideration of the problem before us we had first to deduce, from the theory of washing or concentrating by utilizing differences in specific gravity, certain general rules which all concentrators must follow, viz:

First. The crude products should be crushed just enough to make a mechanical separation of the different components possible, to prevent large flat pieces of the lighter materials from floating small pieces of the heavier.

Second. The crushing should be so arranged as to break the materials into grains whose three dimensions shall be tolerably regular polyhedrons.

Third. Sizing—*i. e.*, separation according to size of grains by means of screening, should precede the washing or concentrating.

Fourth. Suction *must* be prevented in the jigs, as it inteferes with the action of specific gravity.

The last would seem so self evident that I should lose no words about it were it not that there are jigs manufactured to this day whose action is made to depend largely upon suction, *i. e.* upon the pressure of the atmosphere upon the surface of the mineral to be concentrated.

To illustrate let us consider two very simple problems:

1st. We are to separate pyrites of 4.9 specific gravity from coal of 1.29 specific gravity, water being the unit.

2d. To separate galena of 7.4 specific gravity from limestone of 3.18 specific gravity.

Allow six inches for height of discharge or overflow. On one square inch of surface on grating or solid bottom g, we would have a pressure

In Case I.	In Case II.
Pyrites.....1.05 lbs.	Galena.....1.60 lbs.
Coal.....0.28 lbs.	Limestone....0.69 lbs.

Deducting from each 0.22, for water, leaves as net pressure

Pyrites.....0.83 lbs.	= 100 per. cent.
Coal.....0.06 lbs.	= 7.23 per cent.
A useful difference of	92.77
Galena.....1.38 lbs.	= 100 per cent.
Limestone.....0.47 lbs.	= 34 per cent.
and a useful difference of	66 per cent.

Enough to make coal rise above pyrites, and limestone above galena. But now *add* the atmospheric pressure where you introduce *suction*, even calling it imperfect and allowing it only 10 lbs. instead of 15 lbs., and we have

Case I

Pyrites.....10.83	= 100 per cent.
Coal.....10.06	= 93 per cent.
A useful difference of	7 per cent.

Case II

Galena.....11.38 lbs.	= 100 per cent.
Limestone.....10.47 lbs	= 92 per cent.
A useful difference of	8 per cent.

Which leaves it somewhat doubtful if the lighter will rise above the heavier, against the atmospheric pressure thus injudiciously introduced into the problem.

These illustrations are from easy problems, but how could such a jig act with such slight difference as 1.29 spec. gr. for coal and 1.93 for bituminous shale, where in the natural state of affairs the useful difference is 71.4 per cent., and with suction introduced.

To properly bring this atmospheric pressure into a process depending upon specific gravity for its accuracy is an idea worthy of the man who built the syphon to carry back water from his turbine up into his mill-pond in time of drouth.

In spite of the rule above given, we shall still have middlings, or mixed product to deal with. These are caused by chance adhesions of small pieces of the different compounds, thus forming single grains of average specific gravity. These must be again crushed, sized and jigged, and thus with those quantites which will always crush finer than intended, make up so large a proportion of the total, as to make the proper adjustment of the crusher or rolls, a matter of serious moment.

For, as will be shown, a jig, as well as a screening drum can do more on large, than on fine grain, other things being equal.

For a screening drum, this is too obvious to require explanation.

For a jig, where the wave corresponds in height to the size of grain, a layer 0.2 inches high carried over, would contain 4 times the material of one 0.1 high, for the unit of width. This is modified by the fact, that small grains pack closer together than large ones, and that as we decrease the stroke we use more strokes per minute.

The Osterspey jig which we found in use at the Coke Works was invented by Mr. Peter Osterspey, of Mechernich in Rhenish Prussia, * and is there run on lead ores of from 1½ mm., or from 0.06 inch, to 0.40 inches grain. They wash on these machines 1½ millions cubic feet of ores per month, some of it being enriched from 1.8 per cent to 70 per cent lead.

The product averages about 300 cwt. per hour per jig of 22 inches width, the water consumption is 1 cubic foot per minute, equivalent to 0.35 galllons per inch width, per minute.

Mr. Osterspey gives 200 cwt. per hour for 4 mm. = 0.16 inch grain, and 350 cwt. for 10 mm. = 0.40 inch grain.

A coal somewhat similar to the Belleville coal is found in the Saarbruechen district of Rhenish Prussia, and we had examined the works there with a view to adaptation of methods and machinery to our coals. The best conducted works there used separating or sizing drums before jigging, though they had few kinds of impurities to deal with, their coals were richer in fixed carbon than ours, and a reduction of the percentage of ash from 19 to 9, suffices to make a merchantable coke

The loss in washing was variously given as 12,14, and as high as 24 per cent.

The impurities were easily separated, being much heavier than the coal, none containing excessive percentages of ash, so that occasional inaccurate work would not show very badly in the days total washing.

Morover, the sulphur was all in pyrites in tangible lumps and not in flakes, and their lamellae as in our coals, and there was very little, if any, fire-clay in the slack.

About all the coal naturally breaks into nearly cubical fragments, making the crushing easy and the amount of dust small. In my judgment the washing loss should not run over 15 per cent in well managed works there. In structure, the coal has much thicker layers than ours, the laminae averaging about one inch in thickness. Hence, one inch was the maximum size of grain washed, giving of course, very good results as to quantity. The totals varied from 143 lbs. to 230 lbs. of crude coal washed per hour, per inch of width of discharge side, the average being 197 lbs. *i. e.*, on grains running from about 0.1 inch to one inch, generally classed in 4 sizes.

The consumption of water was from 0.39 gallons, to 0.76 gallons per inch per minute.

All the more modern jigs discharged the coal over a bridge of the full width of the machine and as far as possible from the feed hopper. The slate or dross discharges were various, some having full width and some having two round openings with plugs near the front. Had the dross been as much in quantity as in our coals the latter would have been necessarily almost constantly open, causing much larger consumption of water.

With these data before us, we determined to make our improvements, one at a time, testing the value of each before proceeding with another. The first step was to determine the precise nature of our problem.

We found the Illinois coal composed of six distinct components in mechanical admixtures, easy to be distinguished, and separated by eye or hand, with different specific gravities as follows.

Good coal.....1.29 spec. gr.	3 to 5 per cent. ash.	
Bituminous shale..1.93	„ „	72.25 per cent. ash.
Fireclay...about..2.20	„ „	
Calcspar..... ..2.71	„ „	
Pyrites.....4.90	„ „	
Slates....about..2.67	„ „	

The bituminous shale contains a great deal of fine illuminating gas, and is hence useful in boiler coal, but its excessive percentage of ash shows it very injurious in coke, whilst its small specific gravity makes it difficult to separate it from the pure coal.

The calcspar reveals its presence so plainly as to make it easy to deal with. The fireclay is a difficult body to treat, owing to its clogging the meshes of the screens, choking elevator buckets, and settling in a film over the washed coal. The flaky structure of many of the impurities, makes suction an enemy almost certain to defeat accurate washing.

The coal consisting of thin laminae threw the washing of 1 inch grains out of the question, as high as 0.5 inch being first attempted, but a reduction to 0.42 inch as the maximum became necessary, which of course reduced the quantity produced in greater ratio than it improved the quality.

A jig whose action is very uniform, and not liable to derangement while discharging the dross was indispensible.

Fortunately the Osterspey jig has all these good points.

Certain improvements in construction became necessary to adapt it to its work on Belleville coal until it assumed shape here given.

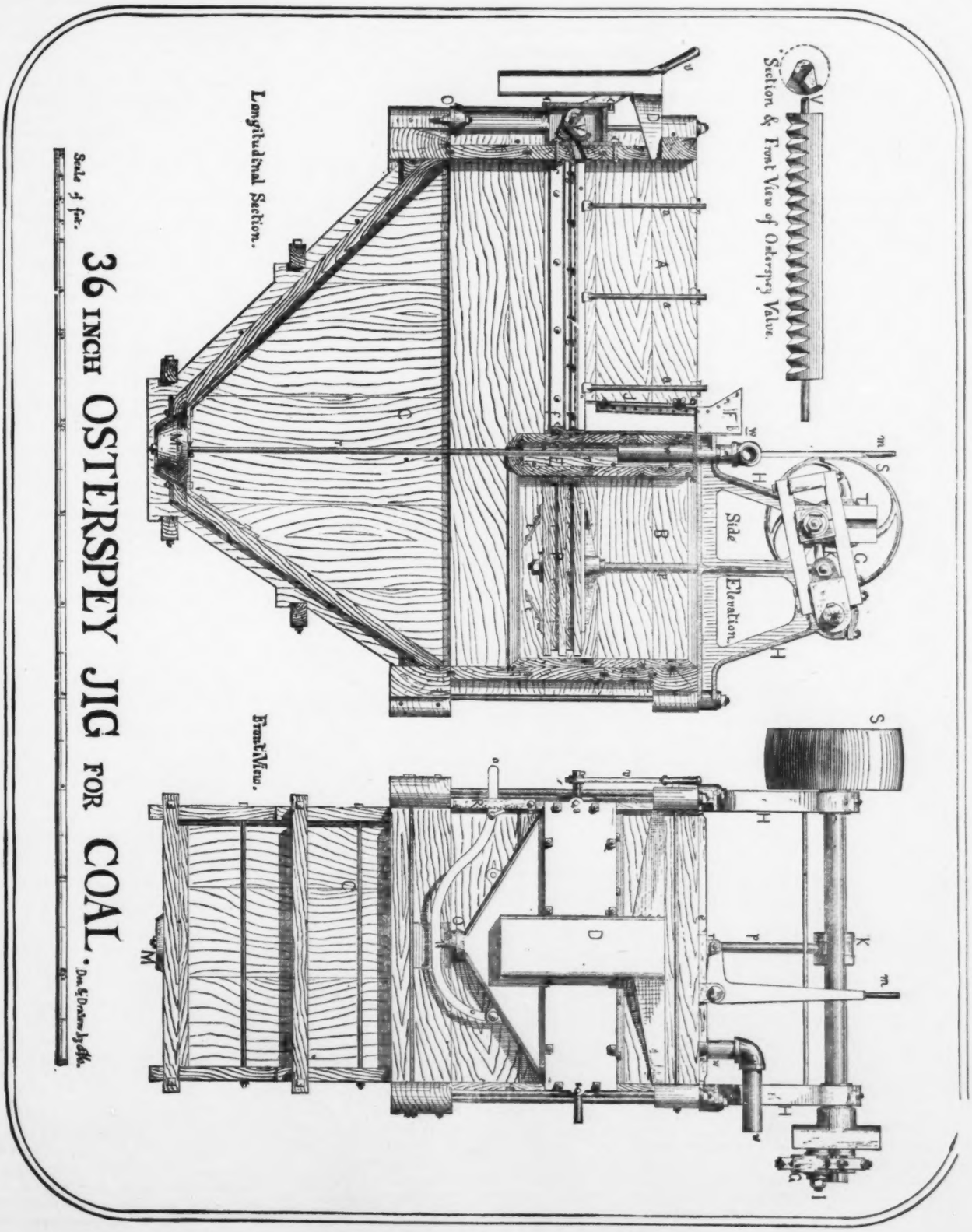
The upper box *A B* is composed of 2" plank, feathered at the joints, and bolted to a stout bottom frame of 4" × 8" scantling and an upper frame of 3" × 6". The bottom frame serves to rest it on floor timbers, either length or crosswise as most convenient. The lower box *C*, also of 2" plank, fits into it, secured by heavy feathers and bolts. It is pointed toward the bottom to cause the fireclay etc. to settle around the mud-valve *M* through which it is discharged.

* This jig was patented Nov. 2, 1869, by Adolphus Meier & Co.

ADOLPHUS MEIER & CO.,

[PATENTED, NOVEMBER 2nd, 1869.]

SAINT LOUIS, MO.



36 INCH OSTERSPEY JIG FOR COAL.

The upper box has a rear chamber *B* with plunger *P* and is separated from the forward chamber *A* with screen bottom *g g*, by means of the diaphragm *E*. This is double and admits the water supply pipe, *W* and the mud-valve rod *r* both of which pass through the crossplate *e* which forms a fulcrum for the mud-valve level *m* and a support for the housing H carrying the two shafts. The forward shaft carries a pully S and a slotted cross-head T in which a tee-headed bolt I is clamped at a point giving the desired stroke. A sleeve on the bolt I works in boxes sliding freely on the guides G attached to the rear shaft thus giving a quick down-stroke and slow upstroke to the crank K and the plunger P.

The bed *g* is made of fine wirecloth, supported on coarser netting, or on perforated plates of iron, braced by six small angle irons crosswise, and two heavier ones lengthwise, held down by keybolts *a a*—and resting on a narrow cast iron frame *f f*.

By driving back the keys and unshipping the six bolts *a a* the whole bed can be lifted out and replaced in ten minutes. By having a few extra bed-screens on hand, we avoid delays in case of choking up by fireclay, or in case of repairs to screens.

The screen plates perforated with fine holes in use in Europe will not answer, frequently choking up with fireclay several times a day.

The coal is fed through a hopper F and *under* the slide J which regulates the quantity.

It is jigged along the whole length of the screen *g*, the washed coal discharging over the bridge through the hopper D. The slates and dross pass through a slot flush with the bedscreen and through the valve V and drop into a pocket, from which they are occasionally drawn by means of the slate valve O.

The main valve V consists of part of the periphery of a cylindrical roller which has been perforated by a number of parallel triangular prisms. This presents to the discharge slot a number of triangular openings, giving, equally distributed over its entire width, just as much free area as is required to continuously discharge the dross as it accumulates on the bed *g*.

When it becomes necessary to open the valve O, the valve V is momentarily closed by turning the lever *v* until V presents its smooth cylindrical surface to the discharge slot.—Then O is thrown suddenly open, the dross washes out, O is as rapidly closed and V slowly returned to the position previously determined as giving the required discharge area.

The plunger has valves *t*, *t* of such opening as to prevent any possibility of suction.

The feed pipe *w* supplies water when needed to fill the jig or to supply the waste when V is closed and O open.

The value of having the lower discharge as far as possible from the feed and of the full width of the screen, whether in washing coal or concentrating ores, will appear upon reflection, and can be shown by ocular demonstration when working a jig.

A certain number of strokes will be necessary to create regular layers of materials of different gravities. Within certain limits this classification must be improved with each stroke. These layers will, in uniform action of the upward currents of water, be of equal thickness across the jig, *i. e.*, perpendicular to the line of travel.

The lower or heavier ores, as well as the upper or lighter ones, should be removed without disturbing that equilibrium which has been so carefully established and which is expressed in their uniform thickness. Hence they should be removed on the side opposite the feed hopper and in even layers of the *full* width above as below. The overflow over the bridge is regulated in this sense by the regular parallel waves, the discharge through the Osterspey valve is of a constant thickness and is evenly distributed over the whole width of the front.

I have frequently verified this by taking up sections of material of the whole height of the mass, at equal distances on lines parallel to the front, and spreading them on a board. Until the hands were skilled by long practice this was their means of gauging the correctness of their work and of determining how often to blow off at O.

When either discharge is made through narrow channels or tubes, either a thickening up of the separate layers must be assumed, or parts of other layers must become mixed with those ready to discharge, causing inaccurate work.

The latter is by far the more probable supposition to any one familiar with hydraulics.

To return to our special problem:

For sizing we found a so-called "Stufenrethe" on hand, *i. e.*, a series of rectangular screens shaken in a horizontal sense by cam motion.

This gave these products, holding in the crude and in the washed state respectively—

Size 1. Crude	19.9 per ct. ash	Washed	11.5 per ct. ash.
" 2. "	16.7 per ct. ash	"	10.2 per ct. ash.
" 3. "	25.2 per ct. ash	"	17.0 per ct. ash.

The average being as before stated 13.35 per cent. in the washed product.

As this did not remove the dust at all, frequently choked up and sized imperfectly, we removed it and put in first a dust drum, removing everything below one tenth inch as dust amounting to 13.8 per cent. of the whole mass and holding 26 per cent. ash, the 86.2 per cent. remaining holding only 17 per cent. ash, out of slack varying from 18 to 22 per cent. ash. The washed product showed only 11.2 per cent. ash average.

The next move was to put in a large classifying drum. To simplify naming the sizes of grain I will give them hereafter only in hundredths of an inch and indicate by the dimensions of the meshes of the screens between which they fall. Thus 10 ⁄ 20 represents that the grain was between 10 and 20 hundredths of an inch in dimension.

Our sizing drum gave us four sizes.

I, 10 ⁄ 20	having	7.25	per cent.	of	ash	when	washed.
II, 20 ⁄ 30	"	8.25	"	"	"	"	"
III, 30 ⁄ 42	"	9.57	"	"	"	"	"
IV, 42 ⁄ 50	"	8.53	"	"	"	"	"

The average from the bins being 9.05 per cent.

The height of bridge or overflow was only 4½ inches as is proper for lead ores. We commenced raising this with the following results, on size III, using double washing:

Bridge 4½	inches	high	9.27 per cent. ash.
" 6	"	"	8.37 per cent. ash.
" 8¼	"	"	7.67 per cent. ash.
" 9	"	"	7.00 per cent. ash.

On larger grains we found 10 inches a safe height.

After some months we found it necessary to abandon our largest size and having put in enough jigs to meet the deficiency sure to arise in the quantity, we arranged to wash between 1-16 inch and 0.42 inch, at the same time in consequence of further experiments, adopting double washing for *all* sizes. Our four sizes now were: I, 6 ⁄ 10; II, 10 ⁄ 20; III, 20 ⁄ 30; IV, 30 ⁄ 42, and our average result the ash reduced down to 5½ or 6½ per cent. Everything over 0.42 inch was first passed through a course jig, and there re-crushed, sized and sent to the jigs.

RECAPITULATION.

	Percentage of ash.	Total reduction in per ct. of ash.
Slack coal as received	18 to 22	
After passing dust drum	16.5 to 17.5	
A reduction of	1.5 to 4.5	1.5 to 4.5
After *single* washing *without* Sizing	11.2	
A further reduction of	5.3 to 6.3	6.8 to 10.8
After *single* washing *with* sizing	9.0	
A further reduction of	2.2	9.0 to 13.0
After *double* washing *with* sizing	5.5 to 7.0	
A further reduction of	2.0 to 3.5	12.5 to 15.0

Or say in round numbers we reduced the percentage of ash from 20 to 6; this is accomplished with a loss of 34 per cent. in weight, *i. e.*, 100 lbs. slack furnish 66 lbs. washed coal having respectively 20 and 6 per cent. ash.

Hence in these 66 lbs. of washed coal there are 4 lbs. of ash, leaving in the 34 lbs. lost 16 lbs. ash, *i. e.*, the dross discarded has 47 per cent. ash and holds most of the sulphur in the original mass. This is a better result than that of the original German experiments since it is obtained without saving the middlings. We refrained from this as it would give us too much fine grain which is difficult to treat on a jig.

We are now experimenting with a sulphur washer on stuff as small as 0.03 of an inch: the results I hope in a few weeks to be able to give you.

One word more as to quantity. Keeping in certain limits as to quality the quantity is also limited. You can easily double or treble it by relaxing these limits, but where two per cent. of ash added may add nearly one per cent. of sulphur, as in Belleville coal, it is not permissable.

The quantities washed, preserving the quality above given, varied from 30 lbs. for the smallest size I, to 223 lbs. for size IV per hour, per inch of width, the total capacity being 21,200 lbs. slack per hour. On Pennsylvania coal the same machinery could easily furnish 60,000 lbs. per hour. Hereafter No I will be thrown on siphon machines and numbers II, III, and IV subdivided to make six sizes. We believe the greater accuracy and regularity of the work will soon pay for the expense of the extra screens.

Our No. IV being about a middle size in the Saarbruechen classification, we can fairly claim to have reached the average in quantity there observed, while the washing is closer and more accurate under more difficult circumstances.

THE FULLERTON AVENUE CONDUIT.

A History of the Various Drainage Schemes of Chicago With Critical Notes on the Conduit at Fullerton Avenue.

By Lyman E. Cooley, C. E.

Written for Engineering News.

III.

DISCUSSION OF STRENGTH, CAPACITY, ETC.

The horizontal pressure in earth is a function of the vertical pressure. When the surface is horizontal the relation is expressed by the well known formula $H = V \frac{1 - \sin \varphi}{1 + \sin \varphi}$ where φ denotes the angle of friction or repose. In the case of clay saturated with water the angle of repose is given at 17° to 14°. Assume $\varphi = 15°$; then $\frac{1 - \sin \varphi}{1 + \sin \varphi} = .588$; i. e., the horizontal pressure on any particle of earth is .588 of the vertical pressure. In the case of the Fullerton Ave. Conduit, in the course of time, the clay about the tunnel will become saturated with water so that the above condition applies.

The geostatic arch is the proper form for earth pressure. When the depth is great as compared with the span this becomes for all practical purposes an ellipse with the major axis vertical. Assuming that condition in the present instance for the tunnel, the relation of the two axes of the ellipse will be expressed by $\sqrt{.588} = .767$; i. e., the horizontal diameter will be .767 of the vertical diameter. For an elliptical tunnel equal in area to a circle 12′ in diameter, the diameters would be 10.5′ and 13.7′, respectively.

Again, in order that the earth shall give away horizontally which it can only do by disturbing the earth vertically, as we suppose the earth incompressible, a horizontal pressure must be brought to bear expressed by $\frac{1 + \sin \varphi}{1 - \sin \varphi}$ or 1.7 times the vertical. In the case of the tunnel this could only be the case when the horizontal axis is $\sqrt{1.7} = 1.304$ times the vertical; i. e., when a tunnel of the dimensions previously given is laid with its longer diameter horizontal.

Between these limits it is evidently possible to construct a tunnel with any ratio of the two diameters, which will be perfectly stable. If the vertical axis be made greater than the limit expressed, the line of resistance will pass out of the middle third of the brickwork, tension will exist in the masonry, and the tunnel will be liable to failure by rising of the crown and collapsing of the sides. In the other case the crown will settle and the sides give way outward. The circular section adopted at Fullerton Ave. is the most convenient and economical to construct and perfectly stable as regards form.

Since the lamentable fraud in the masonry, existing as it does at the deepest portion of the tunnel, the question of strength has been raised.

If the clay should preserve its present hardness the tunnel would be as permanent as if in rock; but it is conceded that under the internal pressure of the water, the clay is liable to become saturated to an unknown distance. As the clay over the roof of the tunnel does not vary much from 30′ in thickness and is overlaid with sand below water level, it would seem as if it might become so saturated that the entire weight of earth above

would be brought to bear on the tunnel. This might especially be true near the manholes and shafts where the tunnel is, to a certain extent, weakened. In any calculation on the strength of the tunnel it is necessary to assume such a contingency.

Taking the depth to the horizontal diameter of the tunnel at 60 ft. which is exceeded in some places and the weight of a cubic foot of damp sand or clay at 120 lbs. the vertical pressure may equal 7,200 lbs. per sq. ft. As the external diameter is 15 ft. we have a total pressure of 108,000 lbs. The thickness of the arch being 1¼ ft. gives a pressure of 36,000 lbs. per sq. ft. or 250 lbs. per sq. in. on the masonry. If we should subtract the area of the upper half of the tunnel this result would be somewhat smaller, but as we have taken the weight of clay at something less than its probable weight in this case, we will assume the result as correct.

Rankine states (Civil Engineering p. 366,) that good, hard, ringing brick, not absorbing more than 1-15 their weight of water should require at least 1,100 lbs. per sq. in. to crush them when set on end, and that a small pillar of such brick laid in cement should not crush at less than 800 to 1,000 lbs. to the sq. in. As the brick at the Fullerton Ave. Conduit are almost vitrified and the cement of good quality, we will assume their strength when well laid at 1,000 lbs. per sq. in. This will give us a factor of safety of 4 which is probably ample under the steady load to which the conduit is subjected. When the tunnel is filled with water the pressure will be relieved by an amount due to its head. Assuming this head at 50 ft. the back pressure will be $50\times12\times62.5 = 37{,}500$ lbs. which woud relieve the pressure on the masonry 87 lbs. per sq. in. giving a resultant pressure of 163 lbs. and a factor of more than 6. So the tunnel has an ample factor when filled and one that is considered safe when empty as may be the case for a short time during repairs, etc.

If the two outer rings are poorly laid or not at all, as is the case for about 600 ft. then the pressure per sq. in. would be $\frac{7{,}200\times13.5}{1.5\times144} = 450$ lbs. per sq. in. or a factor of about 2.2 when empty or about 3.6 if filled. If the two outer rings as laid dry, were carefully laid, as the writer understands is not the case, the tunnel might stand, but he should not like to trust it against any local soft spots that might develope; the uncertainty of such backing and the uncertain condition of the masonry itself.

No method of repairing the condemned portion seems practicable except to turn an extra ring inside. In that case the stress on the masonry would be $\frac{7{,}200\times13.5}{27\times12}$ =300 lbs. per sq. in. This would give a factor of 3⅓ when empty or about 5.4 when filled. This does not give as much strength as the original tunnel, but if the two outer rings should prove better than reported, and that the damage is exaggerated is probable, the tunnel may be assumed, when thus repaired, as of uniform strength.

In any case, the masonry must be executed in a very thorough and concientious manner as the factors are all too small to make any allowance for bad workmanship.

It is the intention to force 400 cu. ft. of water per second through the tunnel. This would give a velocity of 3.535 ft. through the normal section and 4.022 ft. through the contracted section. The objection has been raised that the tunnel will fill up with deposit. It does not seem probable that anything which might be suspended in the comparatively still water of the N. Branch would precipitate at this high velocity. From the sewers that may empty into the conduit gravel and small stone may find their way in. In that case the heavy material would simply be pushed along the bottom into the sumps from which it can readily be removed. The velocity which will move different material is given in the following table.

2.25 feet will move gravel 1" in diameter.
3.33 " " pebbles 1½" " "
4.00 " " heavy shingle,
4.50 " " soft rock, brick, earthware, &c.

If the flow should be stopped when the tunnel is filled with turbid water, sediment would collect at the bottom. This would be taken up when the velocity was restored, and any ordinary deposit could be removed by forcing the current at a little higher than the normal velocity.

All the old formula when applied to conduits of large size give their capacity too small. This was found to be the case in the water tunnels of Chicago, which gave about 17 per cent. more than the quantity calculated by Eytlewein's formula. The following modification of D'Aubuisson's formula (p. 206 "Hydraulics") as corrected by the results obtained in the water tunnels, it is thought, can be relied upon as approximately correct for large brick conduits filled with water.

$$H = \left(.0251718 + .000443\,\frac{L}{D}\right)\frac{Q^2}{D^4}$$

The length of this tunnel is assumed at 12,000 feet. The hight due to friction by this formula is 3.613 ft.

There are at least three right angle bends. Weisbach (Mechanics of Engineering, p. 895, Vol. I.) gives the resistance from a 90° bend at .984 hight due to velocity $\left(.984\,\frac{v^2}{2g}\right)$. For the three bends this amounts to 573 ft.

At the outlet there may be a loss of the hight due to the velocity or .194 ft. This might be done away with by a properly shaped outlet, but is to small to incur extra expense. The loss from change of grades in the tunnel on calculation is found inappreciable.

The fact that the tunnel must be contracted for about 600 ft. of its length will increase the head slightly. If the extra ring is joined to the old tunnel by a gradual curve no loss will be experienced at either end from change of velocity. The increase of head for a smaller section above that required for the original conduit is .035 ft. The sum of these quantities, 4.416 ft. gives the total head required in order that 400 cu. ft. per second may be discharged into lake Michigan through the conduit as constructed.

The discharge of the conduit, 400 cu. ft. per second, would empty, in 24 hours, a prism 200 ft. wide, 10 ft. deep and 17,280 ft. long. This undoubtedly exceeds the present capacity of the North Branch so that the water would be changed at least once in that time.

Assuming the average width of the North Branch at 200 ft. and depth at 10 ft. the velocity would be $\frac{400}{200\times10}$ = .20 ft. per second. The amount of fall in the river from the lake to the conduit may be found by the following formula (Weisbach, p. 966,) $H = .00011748\,\frac{l\,p}{F\,c^2}$. Assuming, $l = 25000$, $p = 220$, $F = 2000$ and $c = .20$; $H = .01262$ ft. or .155 in. or less than ⅛ of an inch. The total hight required to raise the water would be 4.429 ft. This result corresponds closely with that of the City Engineer who gives 4.5 ft.

Some observations on the pumping machinery required, may not be amiss, although we believe the City Engineer has not yet decided on any definite plan, only general calculations having been made. One plan has been discussed somewhat in detail; viz:

To place in the tunnel at the North Branch end, a screw, similar to a ship's propeller, the conduit at that point being divided into two branches so as to give an easy run toward the screw, the machinery being placed between these two branches of the conduit, which again close, leaving a lenticular space for boiler-house, engines &c. The calculated H. P. was about 300. Owing to the uncertainty of data in regard to the efficiency of screws working in tunnels and the fact that it is impracticable at the present time to make experiments, the idea of a screw I understand, has been definitely abandoned. If a screw were adopted it would give greater facility for forcing the water either way than most any other design.

In Europe the centrifugal pump seems to be the favorite for all drainage schemes, many of them being used in England and on the continent and also in Egypt for purposes of irrigation.

In Holland they are fast taking the place of windmills for the drainage of the dyked lands and also for the sewage works in connection with the large cities.

The largest set of pumping machinery in the world is of the centrifugal type, built by J. & H. Gwynne, of Hammersmith, England, for the drainage of the Ferrara Marshes, Northern Italy, and described in *Engineering* of Jan. 7, 1876. These marshes comprise an area of 200 sq. miles, and the pumps are required to discharge 456,000 gallons (73,000 cu. ft.) per minute under a mean lift of 7¼ ft. Eight 54" pumps are used, worked in pairs by compound engines, each pump discharging 9,125 cu. ft. per minute.

To an inquiry addressed to Messrs J. & H. Gwynne in which I gave the data in regard to the Fullerton Ave. Conduit, as 24,000 cu. ft. of water per minute raised 4.4 ft., I received a reply of which the following is an extract.

"We should advise * * * 4 pumps, worked in "pairs by condensing engines, the discharge of each "pump to be 48 in. diameter, *each* pump to be fully "capable of discharging 37,500 gallons," (6,000 cu. ft.) "per minute to a hight of 5 ft. when making 111 revo-"lutions per minute. The actual H. P. required for "both pairs of engines will be 313. We have taken "the steam pressure at 65 lbs. above the atmosphere "and the cut off at 1-5th."

The success of the improved centrifugal pump wherever tried and their almost universal adoption in foreign countries will probably be an argument for their adoption in this case, although it probably would not pay to import them under the present restrictive tariff. No doubt many engine builders in this country can build them just as well and at less expense should it be decided to adopt them. They will not offer as great facilities for driving the water in either direction as the screw, but this can be readily provided for by a suitable arrangement of sluices.

Pumping such a large volume of water seems like a great undertaking, but with the Ferrara Marshes before us and the fact that all the sewage of London has been pumped up into the Thames at Crossness for many years and also, that the city of Boston has recently decided to pump all the sewage of the city and discharge it into the sea at Moon Island, the undertaking is not at all unparalleled and, compared to the benefits that are to result, quite inexpensive.

The objection has been raised that the discharging of so much polluted water so near the city will be offensive. But if the water of the North Branch is changed every 24 hours and thrown into the lake 800 ft. from shore, decomposition of organic matter will not take place until the sewage is so diluted as to become practically inoffensive. The organic matter will also be quickly oxidised by the pure water of the lake. It may be doubtful if any scheme will entirely do away with bad smells somewhere and this will certainly be less offensive than any other method yet presented.

The time will come, as it has already in European countries, when the people will object to the pollution of their rivers.

As Chicago grows, the constant increase of sewage down the Illinois River will cause an outcry against the nuisance by the people along its banks. This will come at no distant day and Chicago will then have to construct a system of intercepting sewers to keep her rivers pure. As all schemes of economical sewage utilization have practically failed and particularly so in northern climes, the lake will ultimately receive the sewage, probably by tunnels which shall carry it far enough into the lake to dilute it beyond danger to health.

In conclusion we wish to acknowledge our obligation to Mr. E. S. Chesbrough, City Engineer, and Mr. B. Williams, Assistant, for access to valuable material and to the work in progress; also to Mr. Potter, a student at the Northwestern University, for assistance in collecting data &c.

The Eads Method of Sinking Bridge Piers.

James B. Eads, the builder of the St, Louis Bridge and the engineer in charge of the work on the Mississippi jetties, has obtained a settlement with the East River Bridge Company and their chief engineer, William A. Roebling, with whom he has had a suit for some time in the United States Circuit Court. Mr. Eads claims that when the defendants found the system adopted by him upon the St. Louis Bridge would prove successful they investigated his methods, which he had patented, and adopted them without his permission. He states that he has gained an acknowledgement of these facts and the sum of $5,000 as damages. The patents which were infringed related entirely to the means used in sinking bridge piers—placing air locks on the inside of the air chambers at the bottom of the piers, and the use of an open shaft in which is placed a circular staircase, by means of which the air lock is reached from above; lining this shaft with a series of wooden staves arranged in the form of rings by which the water is excluded from the shaft; also the introduction of vertical iron pipes, communicating with the air chamber and the surface above the water, through which the sand is expelled from below the pier.—*N. Y. Tribune.*

Contractors' Intelligence.

Pine street, St. Louis, is to be paved with asphaltum. S. R Dixon is the contractor.

The Canadian Government will proceed in a week or two with the dredging of the Owen Sound Harbor.

A. Knisely & Co., of this city have just completed, and have ready for shipment, a job of galvanized iron cornices for the United States Mint Building, in San Francisco, California.

The Board of Managers of the Hudson River State Hospital have awarded the contract for the general kitchen and a large building adjoining to George E. Broas, of Poughkeepsie, for $57,900.

H. Noble, of Fulton, Ill., has built nearly three miles of pile and bent bridging on the line of the new St. Louis, Bloomfield & Louisville narrow gauge railroad during the past eight months.

The contract for piling and bridging for the Seattle & Walla Walla railroad, in Washington territory, of the several sloughs and swampy tracts of land, lying between a point about six miles from Seattle and Black River, has been let by Superintendent Colman to Messrs. Eaton & Webster. The length of trestlework to be constructed by them will amount in the aggregate to nearly a mile, and by their contract they are to have it completed in six weeks.

The amount named in the appropriation bill for improvements of the Connecticut river this year is $20,000, of which $15,000 will be expended in further extending the Saybrook breakwater, and the remainder in deepening the channel at Glastonbury bar and at Pratt' ferry near Wetherfield. Work has already been commenced at the first-named place, which is one of the most troublesome bars on the river, and the contractors are working on credit, no funds being at present available.

The bids for constructing a brick sewer in Worthington street, in Springfield, Mass., 925 feet in length, and a similar one in Pine street 670 feet long, were opened on the 1st inst., and the contracts awarded to D. J. Curtis. The bids were as follows: For the Worthington street sewer, James Dufly, $5000; Whittemore & Sanderson, $3783.25; D. J. Curtis, $3583.75. Pine street, Howe & Hawkes, $4000; Whittemore & Sanderson, $3886; James Dufly, $3819; J. J. Kelly, $3618; D. J. Curtis, $3403.60.

The Clinton Bridge Company, of Clinton, Iowa, were awarded contracts on the 3d inst. for two spans of their Howe Truss Combination bridge across the Maquoketa river in Delaware county, Iowa, one span at Hopkinton of 140 feet and one span at Manchester of 150 feet. The same company have also contracted to erect one span of the same kind of bridge, 180 feet long, across Black River at Black River Falls, Wisconsin. This company have also just completed the work under their contract for the bridging on the 1st division of the St. Louis, Bloomfield & Louisville narrow gauge railroad.

The County Commissioners have awarded the contract for building the superstructure of the new North End bridge, to Thomas Leighton, of Rochester, N. Y., for $71,500. The bridge will be constructed on a factor of six, and of the same style as the Boston & Albany railroad bridge over the Connecticut river. The contract for the filling was given to John McCoy & Son of Holyoke, for 30 cents per cubic yard. It is not probable that the commissioners will reach a decision in regard to the South End bridge at this session.—*Springfield, Mass., Union.*

The progress made on the breakwater has not been so rapid as was anticipated, and at present a length of only 400 feet from shore has been finished. Mr. Strong, the contractor, expects to have the remaining 600 feet completed in two months. That will finish that portion made of pile work. A force of about thirty men is kept constantly at work, driving piles, filling in stone, and at the head of the old river bed building cribs, which are towed into position and then filled with stone and sunk. The piling is filled in with stone and then planked over, and a railway extended out as the work progresses, to convey piles, and stone, and rip-rap filling, put on each side to strengthen the structure. There are nearly enough piles on the ground to complete the contract.—*Cleveland Herald.*

The common council of Green Bay, Wis., have awarded the contract for rebuilding Walnut street bridge to Charles Berner, of that city, for the sum of $3,495. There were six bidders, three of them outside parties. The highest bid was that of J. M. Barker, of Appleton, $7,990. The contract calls for the completion of the work in seventy days. The bridge in question is the oldest one over Fox river.

The First Half-Century of American Railways.

We reprint the following interesting summary of American Railway progress for the last 50 years, from our valued cotemporary, the Chicago *Railway Review*.

Nothing in the history of the past half century is more wonderful than the inauguration, growth and development of the railway system of the United States; for such a thing as a railroad was scarcely thought of, certainly not put into practice, before the year 1826. It is also singular that the year when the city of New York was first connected by water transportation, by the Erie Canal, with the upper lakes, should also see the inauguration (on a small and simple scale, it is true,) of that system of steam land transportation, which has had more to do with the fashioning of the spirit of the present times than any other force. The growth of the American railway system, as told in the pages of *Poor's Railway Manual* for 1876 (the receipt of advance sheets of which we acknowledge), cannot be excelled in interest by any other chapter in the history of our country in the last hundred years.

Previous to 1826 the thoughts of the people, as regarded the transportation of goods, were confined to the construction of canals. The great New York & Erie Canal was constructed, and assured the pre-eminence of New York for the next third of a century at least. The opening of this canal gave an impetus to canal construction all over the country. The States of Maryland, Pennsylvania, Virginia, Ohio, Indiana and Illinos, set thousands of spades to the work of opening up new lines of water communication. Ohio constructed two lines across her territory from Lake Erie to the Ohio River; Indiana constrncted a line from Toledo to Evansville, and Illinois constructed a line from the headwaters of Lake Michigan to the navigable waters of the Illinois River. Pennsylvania undertook the construction of a canal from the Delaware to the Ohio River at Pittsburgh, and only failed in the ultimate completion of the work for lack of water at the Pittsburgh end of the line. Maryland completed the Chesapeake & Ohio Canal to the base of the mountains at Cumberland. The James River & Kanawha Canal was carried to the base of the same range.

But by the time those great works had been completed new ideas began to dawn on the minds of the people. The locomotive had been thought out, built and successfully set to work. The first railway undertaken in the United States was a short line of three miles for the transportation of granite to the Neponset River, near Boston. This was simply a tram road such as had already existed in England for some time, operated by horses. A similar work was constructed at nearly the same time for the transportation of coal from Mauch Chunk to the Schuylkill River. In 1828 was begun the construction of the first railway for the transportation of freight and passengers, and this work was the Baltimore & Ohio R.—ground being broken, July 4, 1828, by the venerable Charles Carroll of Carrollton, the only surviving signer of the Declaration of Independence. In the fall of 1829 the laying of the rails was begun within the city of Baltimore. On May 22, 1830, the first section to Ellicott's Mills, 15 miles in length, was opened. The track consisted of longitudinal sills to which straps of iron were nailed, and this was the structure of all the roads then and for ten years thereafter. The locomotive power consisted of horses; but early in January, 1831, the company invited proposals for the construction of a steam engine, which must not exceed 3½ tons in weight, and be capable of drawing 15 tons, inclusive of the weight of the cars on a level road, Three engines were offered, but the company accepted that of Phineas Davis, of York, Pennsylvania. At first it was feared that the frequent curves of this road would operate to hinder the use of locomotives. but improvements were soon made in them which enabled the machines to surmount those difficulties, and the success of the locomotive was assured. The first locomotive ever used in the United States was imported from England in 1829. It was called the Stourbridge Lion," and was tried on the Carbondale & Honesdale Railroad, on the 8th of August; but being too heavy for the wooden sills of the track, it was consequently abandoned. The first locomotive built in the United States was made at the West Point foundry, New York, in 1830, for use on the South Carolina Railroad, then in process of construction. It was placed upon the road in November, 1830. The second and third locomotive built in this country were by the same manufacturers; the second was for the South Carolina Railroad and the third for the Mohawk & Hudson, now a part of the New York Central. It is remarked as showing that civil engineering was not infallible always, that a commission composed of eminent men, as late as 1829, reported against locomotives and in favor of stationary engines for the moving of cars on railways, owing to the grades, which it was believed locomotives could not surmount. In 1832 the success of locomotives was established, and from that time their development and improvement was so rapid that the locomotive of 1832 would hardly be recognized as the true progenitor of the first-class railway engine of the present day.

In 1833 South Carolina opened the longest line of road in the the world, 135 miles in length. To show the rapid progress of railway building at this time a few statistics ar given, as follows: The Mowhawk & Hudson (17 miles) was opened in 1837; the Saratoga & Schenectady (21½ miles) in 1832; the Cayuga & Susquehanna (34 miles) in 1834; the Rensselær & Saratoga (25 miles) in 1835. In New Jersey, the Camden & Amboy Railroad from Bordentown to Hightstown (14 miles), was opened in Dec., 1830; in four years more it was extended to South Amboy (47½ miles). In 1835 Pennsylvania had a continuous line of canal and railway from Philadelphia to Pittsbugh, and the total mileage of railway in that State at that time was 265 miles. In 1833 the Baltimore & Ohio Railroad was extended to Harper's Ferry, a distance of 81 miles. In the same year the Washington branch was completed. In Massachusetts, in 1835, there were completed the Boston & Worcester Road, 44 miles; the Boston & Providence, 41 miles, and the Boston & Lowell, 26 miles. The total mileage in operation in the United States in 1835 was 1,098 miles.

The second great step in the progress of railway development was the substitution of heavy iron rails for the old composite rail of wood and iron. Until this change the weight and speed of locomotives where limited by the frailty of the track to the most moderate figures. The year 1850 may be fixed upon as the date when the wooden composite rail went out, and the solid iron rail came in. In 1851 the Erie Railway was completed to Lake Erie. In 1842 the New York Central was completed from Albany to Buffalo, by the completion of the Tonawanda Railroad. But the road was practically excluded from railway freights by a law which compelled it to adopt canal rates, until 1851, when this law was repealed, and the Central & Erie roads entered the field of active competion in the same year, 1851. The first twenty-five years of the history of railway construction was characterized by the universal use of the wooden tramway. From 1851, when the solid iron rail was adopted a great period of progress is to be noted, making up to the present time a quarter-century fully as remarkable as the first quarter. In 1857 there were in operation in the several States where railways had been built, a total of 8,876 miles, That figure must be multiplied by nine to give the total mileage in existence at the present time. No sooner had the great lakes been reached than railways began to be constructed westward towards Chicago. The Cleveland & Toledo R. was completed in 1853; The Michigan Central and Michigan Southern were opened from Lake Erie to Chicago in 1852. The Pennsylvania R., begun in 1847, and extended to Chicago, by the Pittsburgh, Ft. Wayne & Chicago, in 1854. The Baltimore & Ohio was opened to Wheeling in 1854.

During this period of rapid railway development at the East, in the Mississippi Valley several independent railways were in progress of construction or completion. The Mad River Road, now a part of the Cincinnati, Sandusky & Cleveland, was begun in 1835, and a portion completed in 1838. The little Miami was begun in 1837 and finished in 1846. The Cleveland Columbus & Cincinnati was begun in 1848 and opened

in 1851. The Marietta & Cincinnati which extended the Baltimore and Ohio Road to Cincinnati, was opened in 1857. The first road in Indiana running east and west was the Indiana Central and the Indianapolis & Terre Haute, opened in 1853. The Ohio & Mississippi was opened in 1857. The New Albany & Salem, now the Louisville, New Albany & Chicago, was opened in 1854. The first road built in Illinois was the Sangamon & Morgan, now a part of the Toledo, Wabash & Western. The second line was the Galena & Chicago, begun in 1848, and opened a distance of 10 miles in 1850. The first line opened from Chicago to the Mississippi was the Chicago & Rock Island, completed in 1854. The line made up of the Galena & Chicago and Illinois Central was the second from the lakes to the Mississippi, and was opened in 1855. The Chicago & Alton was completed the same year. The Chicago Burlington & Quincy was completed to the Mississippi River in 1856, and the Illinois Central the same year. Two years afterwards the La Crosse & Milwaukee was finished from lake to river. In 1859 the Hannibal & St. Joseph was completed from the Mississippi to the Missouri River. The Chicago, Iowa & Nebraska, and the Cedar Rapid & Missouri River Railroads were opened in 1866, and the Burlington & Missouri River R. was completed in 1871.

Although the Southern States commenced the work of railway building early as has already been mentioned, yet the progress of development there has been much slower than in the North. The first road constructed in the Southern States was in South Carolina, begun in 1830 and completed in 1833. In Virginia, the Richmond, Fredricksburg & Potomac was opened in 1837 to Fredricksburg and to the Potmac in 1841; the Richmond and Petersburg was opened in 1838, and the Petersburg & Roanoke in 1843. The Wilmington & Weldon was opened in 1840, and extended to South Carolina in 1853. From Augusta, the Southern terminus of the South Carolina Railroad, the Georgia Railroad was opened to Atlanta in 1839. A line from Atlanta to Montgomery was opened in 1853, and in 1862 was extended from Montgomery to Mobile, and thence to New Orleans, by the New Orleans & Mobile Railroad, in 1870. The first connection made between the Mississippi and the Gulf of Mexico was made by the completion of the Mobile & Ohio in 1859.

The marvellous progress of railway building west of the Missouri River since the close of the civil war, is well known. Lines reaching to Texas, to Colorado and New Mexico, have been constructed and put into operation. The Union and Central Pacific, inaugurated during the civil war, and completed in May, 1869, are alone wonderful monuments of the enterprise of the nation.

Mr. Poor estimates the tonnage of all the railways in the United States in 1857 at 5,672,712 tons, and the total tonnage transported in 1865 at 200,000,000. The following table shows the number of miles of railway constructed each year in the United States from 1830 to 1875:

Year.	Miles in operation.	Annual increase of mileage.	Year.	Miles in oporation.	Annual increase of mileage.
1830..	23	.....	1853..	15,300	2,452
1831..	95	72	1854..	16,720	1,370
1832..	229	134	1855..	18,370	1,654
1833..	380	151	1856..	22,016	3,647
1834..	633	253	1857..	24,503	2,647
1835..	1,098	465	1858..	26,908	2,405
1836..	1,273	175	1859..	28,789	1,821
1837..	1,497	224	1860..	30,635	1,846
1838..	1,913	416	1861..	31,285	651
1839..	2,302	389	1862..	32,120	834
1840..	2,818	516	1863..	33,170	1,050
1841..	3,535	717	1864..	33,908	738
1842..	4,026	491	1865..	35,085	1,177
1843..	4,185	159	1866..	36,827	1,742
1844..	4,377	192	1867..	39,276	2,449
1845..	4,633	256	1868..	42,255	2,979
1846..	4,930	297	1869..	47,208	4,953
1847..	5,598	668	1870..	52,898	5,690
1848..	5,906	308	1871..	60,568	7,670
1849..	7,305	1,399	1872..	66,735	6,167
1850..	9,021	1,650	1873..	70,840	4,195
1851..	10,982	1,961	1874..	72,471	2,058
1852..	12,908	1,926	1875..	74,058	1,917

The tables given in *Poor's Manual* shows that the Western States had about the same number of miles of road in 1855 as the Middle States or the Southern States. In the next year they were decidedly ahead of these groups, and at the present time the Western States have as much railway mileage in operation as all the rest of the United States.

The aggregate capital and debt account of all these roads at the close of the last fiscal years, respectively, was $4,658,208,630 for 1875; $4,221763,594 for 1874; $3.784,543,034 for 1873; $3,159.423, 057 for 1872, and $2,664,627,645 for 1871. Of the total cost, –2,198,601,-281 was made up of share capital, and $2,459,607,349 of various forms of indebtedness, chiefly of bonds maturing at a distant day. The proportion of share capital to debt was as 89 to 100. The average cost per mile of all the roads was $62,725, against $60,425 for 1874, $57,134 per mile in 1873, $55,116 for 1872, and $59,626 for 1871.

The general result of the operations for our railways for the last five years is shown in the following table:

Year.	Miles oporated.	Capital and debit accounts.	Dividends paid.
1875.....	71,759	$4,658,208,630	$77,294,208
1874.....	69,273	4,221,763,594	67,042,942
1873.....	66,237	3,784,543,034	67,120,709
1872.....	57,323	3,159,423,057	64,418,157
1871.....	44,614	2,664,627,645	56,456,681

EARNINGS.

Year.	Gross.	Net.	From Freight	From Passengers.
1875.....	$503,065,505	$185,506,438	$363,960,234	$139,105,271
1874.....	520,466,016	189,570,958	379,466,935	140,999,081
1873.....	526,419,934	183,810,502	389,035,508	137.384,427
1872.....	465,241,055	165,754,373	340,931,785	124,309,270
1871.....	403,329,208	141,746,404	294,430,322	108,898,886

Street Pavements.

We take the following extract from the very valuable report of City Engineer, F. Shanly, of Toronto, Ont.

1. The Guidet pavement of granite blocks, averaging 12x5x8 inches, laid on 6 inches of concrete and 6 inches of sand, used on Broadway, New York, costs about $5 per square yard, has been down for twelve years, and has had $6,000 expended upon it in that time; length, 2½ miles; requires now a further expenditure of $4,000. Laid in our streets this pavement would cost probably $6 per square yard, the material being so much more costly here than there.

2. The "Belgian block" pavement, being stones 5x6 x6 inches average, laid on a bed of sand 6 inches deep. It is used on some of the leading thoroughfares in New York, and answers a good purpose. Its cost is about $3.50 per square yard; in our city this would probably come to $4.

3. The granite blocks used in the city of Boston, 4x 7x8 inches, laid in from 9 to 12 inches of sand or gravel, make an excellent pavement, and the material being close at hand, and comparitively cheap, the cost does not exceed $3.25 per square yard.

4. The Medina stone pavement used in the city of Rochester seemes to answer a good purpose. The blocks vary from 2 to 3x8x8 inches. They are laid upon 16 inches of sand, gravel or broken stone. This pavement is also extensively used in Buffalo, and cost in either city about $3 per square yard; with us it would probably reach $3.50.

Second, the wooden block pavement of which three are several varieties, but which may practically be classed as one, may be said to have been abandoned in New York, its life having been found not to exceed four, or at the most, five years, and is now being replaced with some one of the above named varieties of stone blocks.

In Boston the experience is more favorable to this kind of roadway, the system there pursued being nearly the same as that adopted on King Street in this city, only that the plank foundation is dispensed with, and gravel or sand six inches deep, alone used. On this the blocks are laid, and the whole thoroughly saturated with water for the purpose of settling and consolidating the foundation. In some cases the sand is first saturated with carbolic oil, which, being absorbed by the road, adds to its durability. Some of these pavements in Boston are in good order after a wear of six years.

The cost of this description of pavement in pine or spruce is about $2.25 per square yard. With us the material being so much cheaper, it can be laid down for not more than $2. Another variety of wooden block pavement is being adopted in Detroit, and to some extent in Chicago and other western cities; but from what I can learn there has not as yet been been sufficient experience of it to admit of an opinion of its merits. It consists of round cedar or tamarack blocks about ten inches long, laid on sand or gravel as before, the spaces being filled in with gravel, and in some cases with gravel and tar mixed. It seemes probable that this will make a durable roadway; but I am inclined to the belief that the wear of the blocks will be uneven, causing the surface to become rough, like what is known as the cobble stone roadway.

Several other varieties are used, but they only differ from each other, and the above, in certain small details of little consequence as to relative costs. Any of them can, I think, be laid down at from $2 to $2.15 per sq. yard, where the timber used is pine, cedar, or tamarack; and about $2.50 where white oak is used; which, as regards wear, will be superior to all other timbers, though in the mater of durabillity, otherwise I am inclined to the cedar.

Third, the next class of pavement used in New York and Boston, and also in some of the Western cities, is the asphaltum, or bituminous concrete, of which there are several varieties, the most approved, however, being the "Abbott patent," used in Cleveland and Brooklyn, and the "Grahamite," used in New York and Boston. From the information received, and the specimens I have seen, I am not inclined to favor its adoption in our climate to any large extent. It has been used a good deal, and it is claimed with advantage, in repairing wood and stone pavements, and also in Macadam roads, by coating them with composition to the depth of about three inches. The cost of these seems to vary from $1.75 to $3 per square yard.

So far I have not touched upon Macadam roadways, but I may shortly state that those in the Central Park, New York, answer a very excellent purpose. They are built by first laying down about eighteen inches of large stone blended with fine sand or gravel six inches in depth, or a somewhat smaller stone, also blended as before, then another six inches of the ordinary broken stone and gravel, each layer as placed being subject to a heavy roller and water, freely used.

These roads cost from $2 to $3 per square yard, and are expensive to keep in repair where the traffic is heavy, but they answer very well for parks and streets where pleasure driving is the main use made of them.

SIDEWALKS.

In New York the stone flagging is universal, the cost per square yard being about $3, and of the stone curbs seven cents per lineal foot.

In Boston, brick is chiefly used, costing $1.25 per sq. yard. Where stone flags are used, they are put down at the expense of, and by the property holders.

Concrete, a mixture of tar and gravel, has also been used. The cost is about $1 per square yard, but the experience of it is not satisfactory.

In our climate brick is not admissible, and the concrete would seem, from our own experience of it, to be equally objectionable. The stone flags are very expensive, and in our climate apt to crack open and be displaced by the frost. We are, therefore, brought down to the only alternative—the wooden blocks—the experience of which, in that position, has been very satisfactory. The cost will be not more than $2 per square yard, or probably less.

Whilst I am not prepared to recommend any pavement which is not, as to quality of material and workmanship, the very best of its kind, I am quite alive to the necessity of exercising a wise economy in the selection, and propose that your choice be made from the above pavements, used in Rochester, or something equally cheap and durable, and from the best variety of the wood, which, I am inclined to think, is the oak block. The asphalt or concrete, I would recommend a trial of, on some short streets, covering with it the present macadam.

For sidewalks, I recommend the wooden blocks, and for curbs, the stone stringer; on new sidewalks to be laid down henceforward on certain princpal thoroughfares, to be determined upon in any other way.

In preparing for these improvements it will, I think, be well to call for tenders for each class, without naming the variety, by which means you will be enabled to get estimates for all kinds, and may, perhaps, be placed in a position to make a better selection than I have—upon our present information—recommended.

A great deal has been said lately about various kinds of artificial stone, and some offers have been made for the adoption of it, as curbs, sidewalks, etc., and while I would hesitate to condemn it without some experience of its qualities, I would strongly recommend that it be used only after an ample test, made at the expense of the manufacturers, and to the satisfaction of your Board.

THE DETROIT RIVER CROSSING.

About 630 cars per day, cross the river at Detroit, the transfer being effected by three ferry boats which are frequently in arrears. This is particularly so in the winter season when the boats are not only obliged, oftentimes, to cut their way through solid ice, but the ferry slips in the absence of the boat, are frequently filled with pack-ice to a depth of eight or ten feet. These facts, complied with the unavaidable delays have always made the crossing of the river a considerable tax on the railway companies. The river is also crossed by a railway ferry at Amherstburg, near the mouth, where the Canada Southern railroad connects with western roads, and the Grand Trunk ferry at Port Huron, near the foot of Lake Huron. In No. 27, we noticed the proposition of Gen. W. Sooy Smith in regard to tunneling the river. Last week a new committee of the Detroit Common Council was appointed, consisting of the mayor, comptroller, five aldermen and five citizens, to confer with the railway companies.

They seem sanguine of interesting the railway companies in the scheme, as some other method of crossing will soon become a matter of necessity to the Michigan Central and Great Western roads, if they expect to hold their supremancy in the carrying trade. Already has there been quite serious talk of putting in a tunnel at or near the Lime Kilns, not far from Amherstburg, to connect directly with the Canada Southern. The main channel at this point, lies near the Canada shore, and the railway can be carried on bridges to Grosse Isle, and thence by tunnel under the main channel. This could be done quite readily, and probably by a system of cofferdams, the tunnel being laid just below the bottom in an open cut, as the water is quite shallow, the Government at present being engaged in blasting it deeper. The current is somewhat swift, however, but probably would not introduce features which could not readily be provided for. If such a scheme is much cheaper than the crossing at Detroit, where the water is about 70 feet deep, and entirely feasible, as we understand it is, with Vanderbilt in control of Canada Southern and the Great Western running in conjunction with the Grand Trunk, which is likely to follow soon judging from the present Canadian policy, this question of crossing the Detroit River in the quickest and cheapest way, will find its own solution at no distant day. Should it be at Amherstburg, as may not be unlikely, Detroit will be on one side of the great freight channel and will be obliged to construct a tunnel in self-dense. If she can build her tunnel first the Amherstburg tunnel will probably, not be built, at least for many years, as the Canada Southern can use its branch to Detroit.

A GREAT International road to cross the eastern continent, similar to our own Pacific Road, is now talked of in European circles.

This road is to start from Nij. Novgorod, the present terminus of the Russian system, following the Volga and the Kama rivers, crossing the Ural Mountains near Ekaterimburg, thence in the direction of Tioumen and Omsk on the Irtish River, via Kainsk to Tomsk near the Obi River, thence directly to Irkutsk on Lake Baikal, crossing the Chinese frontier near Kiachta. From the Nij. Novgorod to Tomsk the route is over the so called steppes very similar to our prairies in ease of construction. From Tomsk to Lake Baikal the country is more rolling. The greatest hight on this section is but 3,800 feet. The most difficult portion lies on the Chinese frontier at the crossing of the Altia Mountains near Kiachta. It is expected to open up mineral regions in Siberia of immense richness, and knit the bonds of Russian unity in the Asiatic provinces; at the same time it will open up a new avenue to the Chinese coast, which will be all powerful commercially and as a civilizer.

THE annual report of the Suez Canal Company was made at Paris, on June 27. It contains the gratifying information that, as the traffic on the canal has continued to increase, amounting in 1875, to 1,494 ships, with an actual tonnage of 2,940,708, the receipts have at last exceeded all the expenditures, and a dividend of 1 franc 88 centimes per share is now available. The recepts for the year 1875 were 30,827,194 francs, and the expendi tures, including interest, 29,727,047 francs. The depth of water is kept up, a vessel drawing 8½ metres having passed through the canal. That the canal is so soon making a return for the investment, while perhaps unlooked for by some, indicates that there is a prudent management of its affairs, and that its maintenance will not be expensive.

IN nearly every period of high water we hear of some accident to boats navigating the Mississippi River in attempting to pass the bridge draws. The bridges have become so numerous that river men regard them as the chief obstacle to navigation on that river and far more destructive than sand bars etc. Indeed, it has become the common custom for boats to lie up and not attempt the passage of the draws in periods of high wind and rafts and barges are very frequently destroyed on the piers at any water. The propriety of throwing an unlimited number of bridges across navigable streams we do not propose to discuss, that having already been decided in our courts, but it would seem that additional safe guards should be thrown around the vessel interests which the railways are so much interested in destroying. Of course there are two sides to the question to be considered, but it can be safely said that the railways will always, in the construction of bridges, have to be held with a strong rein, in order to conserve interests which are directly in opposition to railway monopoly.

IF railways cannot be restrained in their unlimited bridging of navigable waters, they certainly can be made to construct bridges which shall be the least hurtful to navigation. In this connexion we have watched with considerable interest the result of the construction of the pile-pontoon bridge of John Lawler at Prairie du Chien. This bridge was completed in the spring of 1874, and patented the following August. Recently the same idea has been patented by Lieut. Com. H. H. Gorringe, U. S. N., of Washington, at least we can see no essential difference in the two designs.

The John Lawler bridge at Prairie du Chien is 8,000 feet long and is constructed in two parts, the pier part, which is an ordinary pile or bent bridge, and the movable part, which consists of three pontoons connected lengthwise and representing a length of 396 feet. These pontoons are 28 ft. beam and 4 ft. high with only one foot draft. There is a second draw in the other channel of the river of 408 ft. length. These moveable portions are strengthened by Howe trusses moving over all. The rise of the river is 21 ft. and to provide for this, aprons or movable stages adjusted by powerful screws are provided. The draw is connected back by a leaf, at a distance equal to the width of the pontoons, so that when the draw is thrown open by the current of the river, an opening of the full length of the draw is provided for the passage of boats or rafts. The draw is again closed by a winding engine operating a chain attached to its outer end. The draw opens with the current in one minute, and is closed, in three minutes which does not compare unfavorably with other draw bridges. The expense of such a bridge, in a place suitable for it, is much less than any other type and the capacity is 1,000 cars per day. River men speak of it as the best bridge on the river to pass, especially in periods of high water or wind.

A bridge somewhat similar has been in operation for several years at the Vermont Central Crossing of the foot of Lake Champlain, near Rouses Pt., N. Y. We understand that the Burlington & Quincy Railroad is soon to erect one similar to the Prairie du Chien bridge at their crossing some miles farther down.

THE meetings of stockholders of some manufacturing corporations have brought out a strong desire and determination, on the part of those most interested, to ascertain the reason why corporations, once most prosperous, have been compelled to pass their dividends and report a falling off of receipts, with heavy losses in the treasury. There are of course many general reasons, but a correspondent of a daily paper gives some particular ones, and adduces a remedy. Speaking of a mill whose stock is one of the best in the market, having steadily risen since 1857, he says, that it has maintained its high position up to the present time, because the corporation has the highest order of brains at both ends and in the middle. Its treasurer is not only a man of mercantile education, but one educated in the best school the city of Boston ever furnished for the specialty of fabrics. As a financial man he has few equals and no superiors. The head of the firm of selling agents is a thoroughly practical man, acting in unison with the treasurer, and furnishing a working team that means success; while at the mills, the agent is a man capable of keeping up his part of the duties of the corporation.

THE President of a corporation may be able to address a large public meeting and quote Latin to his stockholders, but this does not provide for his finances, nor secure the sale of its products at a profit. Goods, to be salable must be what the *people want*. Many clerks behind the counters of our retail dry-goods stores are better judges of this point than the whole army of lawyers and other professional men who have brought our manufacturing corporations to their present low pass. Let the mills employ in every department practical men. The ablest managers of these corporations are the men who learned their first lessons in the retail dry goods stores, and who have then constantly improved their education. They thoroughly understand their market and what are saleable goods. Let such men always be put in charge and we shall hear less, even in times like the present, of passing of dividends and declination in the price of stock.

THERE seemes to be cause for the suspicion that the action of the trustees of the Cincinnati Southern Railway in regard to the letting of contracts is not what it should be, they having, at various times contracted for work to be done and materials furnished upon the line of said railway, without going through the regular formula of advertising for bids. Because of this little informality the Board of Councilmen of Cincinnati met last week and after a couple of "whereases",

"*Resolved*, That a committee of five be appointed to confer with the Trustees of the Cincinnati Southern Railway, with a view of ascertaining the manner in which such contracts are awarded, and the facts in relation to the excess of contract entered into for switch appliances, and that they report the result of their confer ence to the Board."

MATTERS do not seem to be progressing in a manner entirely satisfactory to all parties at the dam of the Worcester water-works, now building to replace the one washed away last spring. City Engineer Blake presented a communication to the city council on Monday evening of last week, in which he stated that the new dam was in several points being weakly constructed. The rebuilding of the dam has been under the superintendance of W. H. Heywood, by appointment of the county commissioners, and has been viewed from time to time by Engineer McAlpine, of Albany, the consulting engineer of the work, so that the city engineer has had no part in the work, but makes his statements from unofficial examinations. The county commissioners examined the dam lately, and discovered that the foundation is wholly insecure.

PARTIES in Boston who own a mine in Colorado, are about to send a ton of silver ore to Hartford, Conn., for the purpose of testing a mammoth revolving furnace invented by James Manes, Sr., of that city, and just completed by the Hartford Foundry and Machine Company. The most noticeable feature of the furnace is a huge iron sphere six feet in diameter, of three-quarter inch iron, with about six inches of fire brick on the interior. This is suspended on iron journals, and on its exterior are circular racks which connect with cog-wheels operated by a hand wheel for the purpose of revolving the globe. At one end is a furnace, the blast from which enters the globe through the hollow axle, and bears upon the ore previously placed therein. During the operation of roasting, the globe is constantly rotated.

ON the Fourth of July the Cincinnati *Gazette* presented to its readers a cut of the new Hoe double web perfecting press on which it is now printed, accompanied by pictures of five other presses that have successively done duties in that establishment, each faster than that which it supersedes. The double web press is said to print, on both sides, at the extraordinary rate of 30,000 an hour. It is unquestionably one of the best presses in the world, and the Messrs. Hoe are to be congratulated on their success.

THE Indianapolis *Journal* remarks: "There is great danger that the projectors of narrow-gauge roads are, at the outset, about to commit the blunder of building their engines and cars too heavy, which will at once defeat in a great measure one of the theories upon which narrow-gauge roads are built. A day or two since, there passed west over the Union tracks a number of narrow-gauge box-cars which were but very little lighter in their construction than those of the standard gauge. Such heavy equipments must soon batter the rails to pieces and require replacing with new ones."

THE Jersey City *Journal* says of Mr. John J. Blair, of Blairstown, Warren County, N. Y.: "Mr. Blair has given many very costly and valuable gifts to his town, and he now proposes to build and equip, at his own expense, a branch railroad from Delaware station, on the Delaware, Lackawanna and Western Railroad, to Blairstown, a distance of about 18 miles. The road will cost about $250,000, exclusive of the right of way, which is furnished by the land-owners on the route. Mr. Blair designs the road as a gift to the people of Blairstown, and for the benefit of the farming population, among whom his life has been spent."

Personal.

C. Brum, C. E., of Rio Janeiro, S. A., who came to this country with Dom Pedro, is spending a week in Chicago, examining its Public Works.

City Engineer Chesbrough, who has been confined to his house for several days on account of illness, is so far recovered as to be able to visit the city hall for a short time daily.

I. Lothian Bell, of England, and Drs. Wedding and Mosler, of Berlin, Prussia, members of the Centennial Commission, have been visiting the Marquette iron district during the week.

"Cower's Ferry" Bridge, Iowa.

Written for Engineering News.

On the 6th of the present month, a bridge letting took place in Tipton, Cedar County Iowa. The bidding was for the substructure, and superstructure of a wagon bridge over the Cedar River at "Gower's Ferry," about twelve miles westerly from Tipton. The site selected is at a narrow gorge in the river just below where the channel is hemmed in by perpendicular walls of magnesian limestone, forty feet high. The channel here is about 460 feet wide, and has a solid rock bottom, and the water at its lowest stage is about 2½ feet deep. The stone for the piers and abutments will be taken from the magnesian beds in the vicinity; the haulage will probably not exceed ½ mile.

The stone used has very regular beds and stratification, so that the work of cutting is small.

The specifications adopted by the County Board of Supervisors were as follows:

Extreme length of bridge 540 feet; width of roadway 16 feet. Floor plank and floor joists to be of hard pine, the plank 3 inches thick. The bridge if not of iron to be with, or without, iron floor beams.

Moving load to be 80 pounds per square foot.

No iron to be strained over 15,000 lbs per square inch in tension, 8,000 lbs per square inch in shearing, and 9,000 lbs per square inch in compression by Gordon's formula for strains of material.

Substructure to be completed by October 1st, 1876, and superstructure by December 1st, 1876.

At the letting, the following bids were received. Trusses all iron. The bids by the lineal foot:

Howe truss	$22 85	Clinton, Smith Bridge Company.
Pratt "	20 25	Z. King. " "
" "	21 40	Missouri Valley " "
" "	20 75	Canton, Ohio. " "
Whipple "	23 50	Cincinnati " "

Combination wood and iron trusses, top, chord, and posts wood.

Pratt truss	$14 49	Raymond & Campbell.
" "	14 40	Missouri Valley.
" "	16 75	Z. King.
Howe "	16 28	Clinton, Smith.
Pratt "	14 75	King, of Kansas.

Arch Girders, all iron.

Arch	$20 00	Canton, Ohio, Bridge Company.
"	21 00	King, " " "
"	17 80	Missouri Valley " "

The second truss of the above list was awarded the contract at $20.25 per lineal foot. The specifications are as follows:

Extreme length of span, 135 feet, center to center, 133⅓ feet; rise of trusses, 21½ feet, from center to center, 20 feet; width of roadway, 16 feet; rolling load per lineal foot, 1280 lbs.; dead load per lineal foot, 520 lbs.; factor of safety, 4, and strains as per the specifications of the board.

By the strain sheet submitted, the greatest strain upon the top chord was 100,000 lbs.—section, 14 sq. inches; greatest strain upon the bottom chord, 92,000 lbs.—section 6¾ sq. inches; greatest strain upon posts, 64,000 lbs.—section 13 sq. inches.

The substructure requires 866 cubic yards of masonry, the bids upon which were as follows:

Contractors.	Masonry. per cu. yd	Rip-rap pr cu. yd.	Excavation per cu. yd.
O'Hanlon & O'Hara	$9.00	$——	$——
Bealer & Co.	7.50	0.75	0.50
E. S. Gulick	7.75	1.00	
D. Armstrong	8.70		
W. Lancaster (piers)	9.25		
" " (abutments)	8.00		
Z. King	8.50	0.80	
Clinton Smith Bridge. Co.	7.87		
Mo. Valley Bridge Co.	8.00		
Cincinnati " " (piers)	8.90		
Cincinnati (abutments)	6.95	0.40	0.25

The substructure was let to O'Hanlon & O'Hara, at $9.00 per cubic yard, they to do all excavation needed and furnish all rip-rap required, free of charge to the county.

It seems to the writer that the Board have made a mistake in selecting so short a span, thus putting three piers in a very contracted channel. The Cedar is one of our swiftest flowing rivers, and the chances are that by obstructing the channel they will lose their bridge in some spring rise when heavy ice comes down.

C. W. IRISH, C. E. Iowa City.

Electricity Against Gas.

The Great Northern railway company of France has undertaken experiments which indicate the approach of a great revolution in the mode of lighting public buildings and thoroughfares. To judge from the reports, electricity seems destined to eclipse gas altogether. A few weeks ago a three horse power Gamme machine was employed to light the luggage department of the Paris Great Northern railway station. This hall measures 20,000 cubic feet, and is generally illuminated by twenty-five gas burners. The new electric light was placed at a distance of ten metres from the ground, and gave a light of a peculiarly soft character, which rendered the use of the dull globe employed to check the irritating glare of gas unnecessary. The light continued to burn the whole evening with great regularity. The success was conclusive, and it is stated that the company intend illuminating the vast structure, containing 300,000 cubic meters of space, where the trains arrive, by the the same process. Electric lanterns of exceptional power will be placed at hights of twenty meters, and at the four summits of a rectangle, so that there will be no shade or dark corner in the whole edifice. M. Tresca has been able to estimate the amount of power required to produced a given quantity of light by the magneto-electric machines. In this respect former experiments had been eminently unsatisfactory. The results have been obtained chiefly from two machines, the first giving a light equivalent to 1858 carcel burners, that consume forty grammes of oil per hour, and the second equal to 302 similar burners. With the former it is easy to read at a distance of 21.40 meters, and with the latter at 7.70 meters. The reflection, also, from the walls is so strong that persons can read at these distances even when holding the book with his back to the light. From a lamp equal to a hundred burners the same result can be obtained at a distance of five meters. Four electric lamps of this power have been in use during last year in the factory of Heilman, Ducomman & Steinlen, of Mulhouse, and give a satisfactory light over an area of 1850 square meters. The most important fact, however, is the assertion that the electric light is a hundred times less expensive than oil, and fifty times cheaper than gas. Should a prolonged and practical application of the new system prove this comparison to be correct, it will utimately compel gas makers to make a great alteration in their charges, if it should not even more seriously damage their interests.—*The Builder.*

Covington, Ky., Water Works.

Covington has long suffered from an insufficient supply of water, and of very bad quality. The committee of the City Council appointed to consider the plans of the engineer, Henry Earnshaw, reported in favor of the second plan submitted. All the plans submitted, contemplate a reservoir system, and the one reported will give a head of 255 ft. at the base course of the Court house, which will be amply sufficient for fire purposes.

The following is a synopsis of the plans presented:

Plan No. 1 would present an area of water surface of 11.5 acres; depth of water, 30 feet: capacity, 84,000.00 gallons; cost, $352,205, or $4,193 per million gallons.

Plan No. 2—Area of water surface, 7.66 acres; depth of water, 30 feet; capacity, 53,700,000 gallons; cost, $282.570.47, or $5,262 per million gallons.

Plan No. 3—Area of water surface, 1.96 acre; depth of water, 30 feet; capacity, 13,775,000 gallons; cost, $198,874, or $14,437 per million gallons.

A New Pavement.

Beloit comes to the front once more with a new invention for the benefit of mankind. This time it is in the line of that absolute necessity, a good street pavement. E. McDonald, Esq., is the inventor and W. T. Crim, Esq., has taken an interest in the patent. Together these gentlemen are now vigorously pushing things, making known the peculiar virtues of their valuable invention and introducing it in the large cities. To give some idea of the character of the pavement we quote from the specifications of the patent application as follows:

This invention consists in constructing a Wooden Pavement, formed of sections of closely fitting blocks of suitable timber, made equivalent to a compact, solid mass, by cementing together the vertical sides of each block. The upper ends, or face of the paving, are perforated with augur holes, in rows, about three quarters of an inch in diameter, and two inches deep, and near enough together so that when filled with the metal plugs or bolts, having their heads projecting slightly above the surface of the wooden blocks, that the tire of any vehicle cannot, in any way, touch the surface. These bolts are, in general, of iron, cast or chilled, but may be of steel or any other metal.

This pavement is intended to be laid upon a suitably prepared surface of either earth, gravel, broken stone, or conerete. But the chief and most important feature of my invention, consists in the employment of metal bolts or plugs as shown, which renders the face of the pavement practically indestructable, and at the same time presents a sufficiently rough surface to prevent the wheels of vehicles from sliding thereon, and also giving enough roughness of roading surface as to effectually prevent horses or other draft animals, or even pedestri- from slipping thereon.

High authorities speak with great confidence of the success of this invention, and a section of it is very soon to be laid in one of the principal streets of Chicago.

We give it the right hand of fellowship and hope great things of it.—*Beloit Free Press.*

The Wrought Iron Bridge Company, Canton, Ohio are running their works at full capacity, 11 hours per day, have about 160 men at work, and 35 to 100 employed in erecting bridges at various points. During the past month they have received over 80 contracts for bridges, amounting to over 80 spans from 40 to 200 feet in length, and costing over $130,000. Among the promiment bridges now in process of construction by this company, are, a 440 foot bridge, 54 feet wide, built in two trusses, two deck arch and the plate girder spans, just being completed at Ottawa, Canada, 500 foot deck truss bridge, in 4 spans of 155 to 615 feet, 38 feet wide, just being completed at Columbus, Ohio; 240 foot truss bridge, 54 feet wide, in two spans at Newcastle Pennsylvania; 700 foot truss bridge in 5 spans at Junction Ohio, 680 foot truss bridge in 5 spans at Utica, Illinois; 300 foot arch bridge, 30 feet wide, in two spans, at Iowa City, Iowa; 200 foot truss swing bridge, 33 feet wide, at Houston Texas, and 500 foot truss bridge 18 feet wide at Salamanca, New York. The contracts received by the company since Jan. 1. amount to over $350,000. —*Manufactvring and Trade Review.*

NOTES.

There are 620 workmen now employed on the State Capitol building at Albany, N. Y.

The loss in the State of Iowa by the recent floods will amount to $1,000,000. The loss in Warren county alone is $300,000.

The President has approved the act authorizing the construction of a pontoon railway bridge across the Missouri River at Nebraska City, Neb.

C. A. Stevens, Vice-President of the Albany & East Albany Bridge Co., has been arrested on charges of embezzling $200,000 wotrh of bridge bonds.

We learn that one of the bridges spanning the Schuylkill river at Reading, known as Lancaster bridge, was destroyed by fire July 9, with loss of $40,000.

At Prairie du Chien an artesian well discharges daily 869,616 gallons of water, with power to raise it 900 feet from the ground. The well is only 960 feet deep.

There are from 1,500 to 2,000 miles of oil pipe lines in the oil region, lying mostly in Butler County, Pa., costing more than $2,500,000. Cost of pumps, tanks, &c., will more than double this amount.

Suit has been commenced in New York by the government against the Pacific Mail Steamship Company to recover $16,968.40, amount of duties due on importation of boilers, cylinders, iron-work, &c.

The report of the engineer of the Lake View waterworks, shows that for the two weeks ending July 15th, 3,297,490 gallons of water had been pumped, using in that time 19,476 pounds of coal at a total cost of $38.39.

Baltimore papers from time to time urge the construction of the Maryland and Delaware ship canal which would shorten the route by 225 miles to ocean steamers, thus saving the circuitous passage by the foot of Chesapeake Bay.

An injunction was served on the City Council of Fort Wayne, Ind., Tuesday evening, restraining them from accepting the water-works contract, which at present amounts to $380,000. One of the reasons claimed for the injunction is that a proposal was presented offering to build them for $100,000 less. It is said that an effort will be made to accept the contract over the injunction.

At the annual meeting of the stock holders of the Birmingham and Pittsburgh Bridge Company held on Tuesday of last week the following named persons were elected Directors for the ensuing year. Messrs. A. Garrisson Jonathan Lenz, John Wilson, Thomas Fawcett, A. G. Walter, H. S. McKee, T. B. Atterbury, A. B. Stevenson, John Gallaher, Charles Evans, James Fawcett, J. B. Wolf, Adam Trautman.

The Portage City, Wis., *Advance* says: The first boat through the new Portage canal was the government steam barge, "Boscobel," which passed through the upper lock Friday, June 30, steamed down the canal to the lower lock, and back freighted with some of the government employes, city officials, and some common folks. The completion of the canal connects us by water with Green Bay, the lakes and all the rest of the world.

The King Iron Bridge Company of Cleveland, Ohio, cannot complain of a scarcity of orders however much present prices may be unsatisfactory. They have within the past ten days received orders for eleven bridges from Iowa, and they recently received the contract for a bridge of six hundred feet in four equal spans, to be erected over the Juniata, at Lewistown, Penn. A bridge of 275 feet in length for West Virginia has just been completed. Since January 1st, one hundred and forty-five bridges have been entered upon their books.

The trouble in regard to the suspension bridge at Minneapolis, is finally adjusted and the bridge will probably be completed this fall. The wire of John A. Roebling's Sons, which was first condemned by the bridge engineer, Mr. Griffith, on account of brittleness and inability to splice, having stood the test of tensile strain, and a new method of splicing having been found successful, has been finally acepted. Mr. Griffith has not been discharged as was at first contemplated, and he, with City Engineer Rosser, will push the structure to an early completion.

Angel & McCormick, of Cleveland, Ohio, lesses of the McNairy, Claflen, & Co's works are building a wrought iron bridge 156 feet long for Union county, this State, also an 80 foot bridge with four girders for the Lake Shore railroad crossing over Wilson avenue; this bridge is for four tracks. This week will complete the iron work for the new county building, on which they have been engaged for some months.

Foreign Intelligence.

A movement is on foot for obtaining better drainage and an abundant water supply for Naples, Italy.

The receipts of the octroi of the city of Paris between January and June amounted to 52,573,009 fr.

A report is current that Mr. Henry Meiggs has concluded a contract with the government of Nicaragua for the construction of an inter-oceanic canal.

Sanitary reform has extended even to Algeria, where a country larger than Great Britain has been districted and a sanitary officer appointed for each district.

A Berlin mechanician has invented a steam velocipede which is said to answer admirably. The engine is heated with petroleum, and, being placed on the two back wheels, does not interfere with the convenience of the driver.

The deepest Atlantic soundings ever made were ninety miles north of the Island of St. Thomas, in 3,875 fathoms. The pressure was so great at this immense depth that the bulbs of the thermometer, made to stand a pressure of three tons, broke.

To obviate the danger arising from dampness in brick buildings, a French architect, M. Sebille, has patented a simple and inexpensive process for injecting brick, tiles and other earthern materials with the tarry residue from the manufacture of illuminating gas. Brick thus prepared is said to be rendered absolutely water-proof.

The Whitehead or "fish" torpedo, one of the most ingenious war machines of modern times, is continually undergoing improvement, the latest of which is the abolition of the fins. These were until now thought essential for the preservation of an even keel during the torpedo's journey, but the rudder and other arrangements are found ample for this purpose, and the torpedo has been improved in certain important particulars by the abolition of the useless appendages. It is understood that two large torpedoes sold by Mr. Whitehead to the Russian government for £10,000 are without fins.

An illustration of the value of timber, in England, on waste lands is afforded by the sale of wood which took place on the estate of the Earl of Cawdor, in Nairnshire, England, the other day. In 1820 two hills, about three hundred acres in extent, were planted with fir and other trees, and after successive thinning, the sale of which realized large sums, the remainder of the wood has just been sold off for the sum of £216,000. The sum realized for the wood on this waste land during the fifty years is stated to be equal per acre to the return for the best arable land in the country.

The labor question in England has again become one of serious importance. Trade must be depressed indeed when not only reduced wages and reduced time, but a limit of four working days in the week, are determined upon. Whether such reductions are justifiable or not their effects cannot fail to be most deplorable. At the present rates the condition of English operatives is not a happy lot. With reduced wages, and only four days in the week to earn even this, no fate could be much worse than is likely to befall them. Depressed as everything is with us we have not yet fallen so low as the condition of things in England.—*Quebec Chronicle.*

Several years ago, an Imperial College of Engineering was established in Japan, for the purpose of educating native engineers for the Department of Public Works. Admission to the school, says an English exchange, is obtained by competitive examination, the course of instruction is very complete, and the college is at present under the management of English Professors,—the English language having apparently been adopted as the scientific tongue. In connection with this institution there are well-fitted laboratories and work-shops, of various kinds. The special courses are civil and mechanical engineering, telegraphy, architecture, practical chemistry and metallurgy. The number of students at the close of last year, was 272.—*Exchange.*

Railroad News.

The Pullman cars are not paying in England.

The Cincinnati & Terre Haute railway will be sold to the highest bidder, on the 6th of next month.

The Empire Car Works, York, Pa., are building 500 cars for the Texas Pacific R. R.

Tracklayers are at work on the Cincinnati Southern road south of Nicholasville, Ky., and large quantities of rails are being shipped thither by the Kentucky Central.

The Port Dover & Lake Huron is completed from Port Dover, Ont., on Lake Erie, to Stratford on the Grand Trunk R. R., a distance of 63 miles.

The travel on the Lehigh Valley Railroad has increased to such an extent of late that the company has found it necessary to run their through trains in two sections.

The Kansas Pacific R. R. notified the County Commissioners on July 11, that they accepted the bonds of subscription and will proceed at once to build their road to Trinidad, Colorado.

The old wooden railway and highway bridge across the Hudson River at Troy, N. Y., is being rapidly dismantled and replaced by a substantial iron structure. This is an improvement which has long been needed.

A road on the prismoidal, or one rail plan, is to be built in California to connect the town of Sonoma with Sonoma Creek Landing. Two miles are first to be built as an experimental section and if that succeeds it is to be completed to Sonoma and farther extended to Santa Rosa.

The London *Times* strongly opposes the placing of the bonds of the Quebec Government, for the construction of the North Shore Railway, on the English market, claiming that the scheme is in direct opposition to the railway interests of Canada, helping to destroy property that already exists and cannot pay, for a generation at least.

An effort is being made to extend a railroad from Des Moines northward to Minnesota, via Audubon, Palo Alto, and Emmet counties, Iowa. Jackson county, Minn., has raised $100,000 to be given the first road which reaches there; Audubon county, Iowa, has a like sum to offer; and Palo Alto, Emmet and Pocahontas counties may be set down for $30,000 each.

To prevent forfeiture of charter the Texas & Pacific Railway Co. is working to complete two jobs in that road by the middle of August; one, thirty-five miles west of Dallas, Texas, between Eagle Ford and Fort Worth, on the main east and west line, and the other ninety-two miles on the Fort Worth and Northeastern branch, or Transcontinental branch, between Paris and Sherman.

The Watchung Railroad, a branch of the Midland, Montclair and Greenwood Lake Railroad, commenced running regular trains to Orange N. Y., on Monday the 10th inst. Its terminus is in Orange near the entrance of Llewellyn Park, and passengers are landed in less than an hour, by Jersey City Ferry at Cortlandt and Desbrosses streets, in New York, avoiding the Erie tunnel.

The bridge builders have begun to drive piles for the draw or centre pier of the Chicago, Milwaukee and St. Paul railroad bridge at LaCrosse, Wis. To guard against accidents the railroad company has stationed a watchman at Winona, who notifies every passing boat and raft of the condition of affairs at the bridge. As a still further precaution, the coming of every boat and raft is telegraphed from Winona to the bridge force. Captains and pilots are thus put on their guard, and every care is taken to prevent accidents.

The work on the Green Bay railroad branch into this city was really commenced yesterday. Messrs. Smith and Rossiter having broken ground and got a crew and teams at work just east of the cemetery. To-day a crew will be put on at Onalaska, where the road will form a junction with the Northwestern road, on the table land, a few hundred feet below the depot building. It is now expected that the Northwestern road will build in from the Junction so as to intersect the Green Bay road here in the city and thus form a Y by their main line and their branch, which will be a great convenience to them in handling their trains.—LaCrosse *Democrat*, July 11.

On the New Science of Graphical Statics.

BY MANSFIELD MERRIMAN, C. E.

Instructor in Civil Engineering in the Sheffield Scientific School.

[Written for Engineering News.]

Graphical Statics is a branch of applied mathematics which furnishes methods for investigating the stability of engineering structures by means of simple geometric constructions with dividers, ruler or triangle. Bringing as it does to the Engineer the means of solving statical problems by the tools with which he is most familiar, it is not surprising that it is coming into extensive use in the practice of the profession. Although its very name is scarcely ten years old, its growth has been rapid and healthy and it is today, through its extensive literature, established upon as firm a basis as many much older branches of science.

Mathematical investigations may be pursued by two distinct kinds of reasoning, the synthetical and analytical. The first, starting from simple fundamental axioms, proceeds step by step to deduce laws and relations which, in their turn, are again used for the investigation of more complex phenomena, the second, starting from general relations, runs backward to determine particular laws and properties. As an example of the first we have the pure Geometry of Euclid (—285), of the other the Analytical Geometry of Descartes (1596—1650). The reasoning of our new science, the Graphical Statics, is essentially synthetical.

In all ages it has been one of the aims of mathematicians to solve problems by graphical processes. Those propositions teaching us how to bisect a given line, to construct a square equivalent to a given rectangle, to construct a square equivalent to the sum of two given squares, etc., which were first presented in the elements of Euclid are essentially graphical and are the foundation of what may be termed the Graphical Calculus (*das graphische Rechnen*). Under this head we may class those graphical processes which, like the above, teach of the addition, subtraction, multiplication, division and reduction of the geometrical magnitudes, those of later origin relating to the extraction of roots, involution of numbers to required powers, the solution of numerical equations, and the operations of differentiation and integration, as well as those in mechanics for finding the centre of gravity of figures by means of axes of symmetry. All such problems, it must be observed, though graphical, form no *method* or *system*, but each depends for its solution upon an independent process, which is often the geometrical interpretation of analytical algebraic reasoning. The Graphical Calculus although used incidentally in all graphical *methods* forms properly no part of the subject before us,

As an example of a purely graphical method we may instance the Descriptive Geometry of Monge (1746—1818), which, in representing geometrical magnitudes by their projections upon co-ordinate planes, furnishes a system, a routine, for investigating the properties and relations of given magnitudes. Its processes are not the interpretation of the Cartesian Analysis, but are deduced by sythetical reasoning from the same definitions and axioms. So the Graphical Statics, in its force and equilibrium polygons, affords a routine by which the relations of forces in equilibrium may be investigated, and although dependant upon the same fundamental principles as Analytical Mechanics, its method of reasoning is essentially synthetical and independent of the latter.

In 1864 there appeared the first part of a book entitled *Die graphische Statik* by Professor Culman of the Zurich Polytechnic school, and in 1866 the complete work was given to the public. As early as 1860, however, the elements of the Graphical Statics had been given by Culman in the form of lectures to the students of the Zurich Polytechnic. His book, although presenting for the first time the elements of a new science, stands unequaled among the now extensive literature as a model of scholarship and the work of a master. It consists of several hundred octavo pages, and contains (besides numerous applications of the Graphical Calculus) a full developement of the elements and methods of Graphical Statics, viz., the properties of force and equilibrium polygons, their application to determination of the centre of gravity, moment of inertia, strains in roof trusses and bridges, the investigation of stone arches and retaining walls, as well as the treatment of continuous girders by a combination of analytic and graphic methods.

In developing the principles of the new science, Culman, perhaps unfortunately (but fortunately as will be seen in the sequel), chose a method extremely unattractive to any except good mathematicians, inasmuch as he supposed on the part of his readers an acquaintance with the Geometry of Position, a branch of pure mathematics as then entirely untaught in the schools and scarcely known except among *savants*. Yet such was value of the practical methods there brought out, that they were not only favorably received by scholars but perceived and adopted by engineers, and in the years following the publication of Culman's treatise the most lively interest was manifested by the scientific world in spreading and developing the young science.

The presentation of the subject in the manner chosen by Culman would probably have been the death blow of the system in any country but Germany, and it is perhaps partly due to this, that until very recently the name "Graphical Statics" has scarcely been known to the English and American engineering public. In Germany however the book was read, the value of its methods realized, and the demand immediately made, that the subject should be taught to the students in the Polytechnic Schools. To use Culman's work, however, a knowledge of the Geometry of Position was necessary and a text book on this subject immediately appeared to supply the want.* The end proposed by Cullman was attained, for not only the Graphical Statics but the new and elegant Geometry of Position, were soon placed upon the curiculum of the scientific schools and are now taught in every Polytechnicum in Germany.

A co-worker with Culman in the development o Graphical Statics was Mohr, then a Professor at the Hanover Polytechnic, now at Stuttgart. To him is due the solution † of the continuous girder, which Cullman had given up as impracticable by the graphical method. This elegant solution renders it possible to determine the movements and reactions at the supports of a continuous girder by the use of force and equilibrium polygons alone, by direct and simple processes.

The treatment of Graphical Statics by the new Geometry, although perhaps more elegant, is however by no means necessary, and in later German works‡ the subject is developed from the principles of mechanics by the use of only ordinary geometrical and algebraic reasoning. Under such treatment the acquisition of the method is easy, even to those who have only had the benefit of limited mathematical treatment.

Besides the works we have just quoted in the foot note, there have appeared in German scientific periodicals numerous articles containing extensions and improvements of the Graphical Statics. Of these we have not space to even quote the most important. To give the reader an idea of the interest which the subject has awakened, we will merely mention that in a single German magazine *Der Civilingenieur* there were published in the year 1873 and 1874, fifty-five original articles on engineering subjects, and of these *fifteen* were devoted to graphics. The book of Culman has been long out of print, and he is now engaged in preparing a new edition, which, it is expected, will be superior to anything that has appeared and which is awaited with great interest by German Engineers. § Such is a brief history of the rise and progress of Graphical Statics in Germany. In these ten years it has been established as a study in all their schools for the training of engineers, has excited the study of scholars, has been adopted in the practice of their architects and engineers and has produced an extensive and valuable literature. As its founder gave his book to the world, he probably never anticipated such a wonderful growth as this.

In other countries the system has been favorably received. In Italy it is already taught in the courses of engineering study,‖ and has received the attention of their distinguished mathematician Cremona, whose work on the subject has appeared both in Italian and German.** In France it is already demanded that the engineering schools shall teach the subject,* literature is rapidly appearing, and at least one comprehensive work has been produced. In England one application of the system—the use of the force polygon in determining strains in roof trusses—is very widely known † and is there called "Maxwell's Method of Diagramming." In the Hungarian and Russian language, there is also, we understand, some literature upon the subject.

In our own country the new science is becoming rapidly known. The work of Prof. Greene on the Analysis of Bridge Trusses‡ besides the usual applications of the equilibrium polygon, contains a simple and original method for the investigation of continuous girders and draw spans, while his able articles in the columns of ENGINEERING NEWS, have drawn wide attention to the elegant method for the determination of strains in roof trusses; and the work of Prof. DuBois,§ presenting as it does applications of the method to a wide range of problems in civil engineering, renders easily accessible to the American public the labors of German scholarship to which we have called attention above. In our leading scientific schools, the subject has been introduced into the engineering courses of study and found to be one in which the students take particular interest.

It is not here the place to criticise either of the books to which we have just alluded. We cannot, however, holding the views that we do with regard to the limits and scope of Graphical Statics, refrain from expressing our gratification that Prof. DuBois, although writing a work upon Graphics, has nowhere left analytical processes out of sight; in fact the book contains the whole analytical theory of flexure, from the elementary cases of simple beams, up to the more complex subjects of the continuous girder and the braced arch. The engineer has then *two* methods, the graphic and the algebraic, and in all constructions each should be used to check the accuracy of the other.

Unlike Analysis, which furnishes us not only with processes for the solution of problems, but also general laws and properties concerning the objects of our reasoning, Graphics gives us processes only. For example, Analytical Geometry gives us, by the combinations of the equations of two circular cylinders, the equation of the curve of their intersection, from which we may determine general properties regarding the form, or length of *all* such curves of intersection; Descriptive Geometry on the other hand affords a general method or routine, by which, with drawing-board and tools we may find the curve of intersection of any two *given* cylinders, its form, or length; but deduces no laws regarding such curves in general. So Analytical Mechanics furnishes by its algebraic methods the means of solving problems concerning the equilibrium of forces, and in the investigation of any particular question deduces general laws applicable to all questions of the same class; Graphical Statics presents only the method, by following which, we come to a particular solution of the problem before us. It will be seen, then, that the solutions of Analysis are the more general, that the result is a law for all similar questions, while the solutions of Graphics give us only numerical results, useless except for the data of the given problems. As far, therefore, as the generality of these results is concerned, Analysis is the more powerful and superior instrument of investigation.

Another point for consideration is the process or routine of investigation in the two cases. In such an article as this, it is impossible for us to place clearly before the reader a comparison of the analytical and graphical processes, even for a particular problem, and we must be content with recording our own opinions of their relative merits, not neglecting however, the views of German critics. ‖ It may be said, then, that in the treatment of most statical problems, the methods of Graphical Statics are more general and are more easily retained in the mind than those of Analysis. By "more general" we mean here, subject to less variation as the character of the problem changes. For instance, in the

* Reye; *Die Geometrie der Lage*, Hannover, 1866 and 1868.

† See *Beitrag, etc.*, in the *Zeitschrift des Hannover Ingenieur-Vereins*, 1868.

‡ Von Ott; *Die Grundzuege des graphischen Rechnens und der graphischen Statik*; Prague 1871.
Bauschinger; *Die Elemente der graphische Statik*, Munich, 1873
Winkler; *Theorie der Bruecken*; Vienna, 1872.

§ The first volume of this work has just been issued.

‖ Mohr; *Die graphisse Statik; litterarische Revue; Der civilingenieur*, 1875, p. 230.

** Cremona; *Elementi di calcolo grafico*. Turin 1874. *Elemente des graphischen calculs*. Leipsic 1865.

* Levy; *La statique graphique et ses applications aux constructions*. Paris 1874.

† Unwin; *Iron Roofs and Bridges*, London 1867. De Bow; *Economies of Construction*, London, 1873.

‡ Greene; *Graphical method for the analysis of Bridge Trusses*, New York, 1875.

§ Du Bois; *Elements of Graphical Statics and their application to Framed Structures*, New York, 1875.

‖ Weyrauch; *Ueber die graphische Statik; zur Orientierung*, Leipsic, 1874. Also Mohr,—the article in *Der Civilingenieur* quoted above.

problem of the two cylinders already considered, let the conditions be slightly varied, so that the bases shall be elliptical and the intersections oblique. These variations affect in no way the graphical treatment; proceeding in exactly the same way as before we make our drawing, and deduce the required numerical result. The analytical process is however greatly complicated, new quantities enter the discussion, new algebraic forms arise, and new laws are found to exist. So in the determination of the moment of inertia of figures, the Graphical Statics gives us a solution applicable to the most irregular as well as the simplest forms, proceeding in each case by the same definite processes wherever the axis of moments be taken; by analysis the value is easily obtained for a simple figure with a symmetrically placed axis by the solution of a simple integral; change, however, the direction of the axis or let the figure become irregular and the process is immediately complicated by the difficulty of handling the algebraic expressions which arise. Hence graphical methods are easier to remember, and their application to particular problems more ready in the hands of most engineers, than are the processes of analysis.

As to the accuracy of the results obtained by the Graphical Statics a few words are perhaps necessary. Culman in the preface to his work, estimates that the inaccuracies of the drawing cause errors of about one per cent. in the quantities to be determined. Weyrauch has observed somewhat greater errors, at the highest, however, only of two or three per cent. Mohr, however, questions whether any estimate of error by percentage can be made, for the unavoidable inaccuracies of drawing are in no way proportioned to the results to be derived. The degree of complexity of the process, the skill of the draughtsman, and more than all, his knowledge of the *why and wherefore* of every line he draws, have each an influence on the accuracy of the results obtained. In most cases, however, the results derived by graphics are universally acknowledged to deviate but slightly from those of analysis and to be sufficiently accurate for practical purposes.

As to the ease of solution of statical problems by Analysis and Graphics or the relative time employed by the two processes, it would be a waste of words for us to attempt a comparison where no comparison is possible. While a mathematician would solve tedious problems with his equations and integrals, and smile at the idea of using drawing-board and triangle, another, ignorant of the higher analysis might in the same time accomplish the same end by the processes of Graphical Statics. To the one, analytical methods are easier, to the other, graphical; sometimes the result sought is attained quicker by the first, sometimes by the second. He who is acquainted with both, will use the one or the other or a combination of both, according to the character of the particular problem before him.

In the opening paragraphs of this article, we have classed the Descriptive Geometry and the Graphical Statics together as graphical *methods*, the first is supplementary or parallel to the Cartesian Analysis, and the second to analytical statics. The comparison is not however perfect, for the synthetical reasoning employed in deducing the processes of Descriptive Geometry derives no assistance from the algebraic methods of Analytical Geometry, while many of the most important applications in Graphical Statics are only developable by the use to some degree of analytical processes. As such, we may instance the treatment of moment of inertia, the development of the relation between the catenary and equilibrium polygon, which renders possible the solution of the continuous girder, and the interesting subject of the braced arch with fastened ends for which no purely graphical method of determining the external forces has yet appeared. The treatment of Culman, which uses the Geometry of Position in developing the methods of Graphical Statics, is undoubtedly better designed to render its reasoning synthetical and independant of, though parallel to, Analytical Statics, than that adopted by subsequent writers. Nevertheless as the practice of the method is of more importance than the elegance of its theory, we cannot regret that Culman's development has been laid aside, and the science presented in such a way as to render its more common and important applications accessible to all.

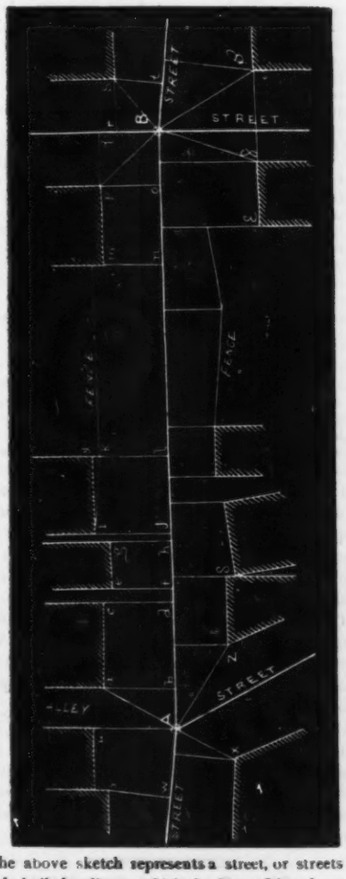
As the more powerful and more general instrument of investigation, Analysis will always hold a place which Graphics can never hope to fill. In the office of the engineer, however, the latter will meet with a ready welcome, for it brings to him easily acquired and easily remembered methods of investigating the strength of his designs, in place of the too often blindly used formulae and rules of thumb that his limited mathematical training has forced him to employ. Neither analytical or geographical methods are mere machines, like the slide rule of the mechanic, by which numerical results may be ground out. Their successful use depends upon a thorough acquaintance with their fundamental principles and a perfect understanding of the theory of their processes. These once attained, the method of each will be used as a check upon the other, the application to the designing of structures will be easy and the results trustworthy. Here as in all other theoretical engineering work, principles should precede rules. "For the calculation of engineering designs," says Mohr, "is only of real benefit, when it is carried out, even in the details, not according to rules of thumb, but with a thorough knowledge of underlying principles."

Street Surveying.

BY FRANCIS LE BARON C. E., BOSTON.

[Written for Engineering News.]

The method of surveying which I shall attempt to illustrate, is one which I have frequently used with advantage in the survey of city or town streets, where the greatest possible accuracy was desired. It has the advantage of such *checks* that a mistake is sure to be discovered and its locality fixed. It is a well established axiom in accurate surveying, that too many *checks* can hardly be taken to prove, *beyond the possibility of a doubt*, the correctness of the work.



The above sketch represents a street, or streets in a closely built locality on which the Street Lines have not been determined and it is desired to make a survey and plan for their establishment. I first measure the base line A B as carefully as possible. Then with my instrument at A, I take the angle, *a* A B, and clamp the intrument on B. My assistants then measure the distances *a b- c d- e f*—which they do by holding the ring end of the tape on the building or fence at *a-c-e*—and swinging in the distances which are determined through the telescope, and which are the *shortest* distances, and consequently are at right angles to the base line A. B.

These offsets measured, they next proceed to measure "the side lines" *ac- ce- eg- gi- ik* and also *iy* and *yk* and so on. They also measure the direct distance A *a* and B *f*. The instrument, in the mean time is set up at B, and the angle A B *f* measured. The field work of over half the street is then completed. The other half of the street is of course taken in the same way and at the same time, and also the angles to the opposite corners, and the main base line angles, provided the survey is to include the adjoining streets. I have taken one side simply, for this illustration. In the office, before proceeding to plat, the calculations of the abcissas A *b- b d- df-* are made in the following manner. In the first case A *b-* we have in the right angled triangle A *a b* the angle *b* A *a* and the side A *a* by which we calculate A *b*, and also *a b* for a check. In the quarilateral *a b c d* we have $bd = \sqrt{(ac)^2 - (ab - cd)^2}$ in the same way for *df. fh* and *hj*, $jl = \sqrt{(ik)^2 - (ij - kl)^2}$ and so on. The abcissas being all found their sum should, of course, equal the measured length of the base line A. B. We now proceed in the same manner with the opposite side of the street, and if this result agrees with the others we have two distinct checks to prove the length of the base line on either one of the side lines. Should two lines agree and the third vary, the reasonable inference, at once is, that the odd line is wrong and it is at once remeasured.

Having established the correctness of our operations we proceed to plot by laying down the abcissas on the base line and producing the rectangular ordinates the proper length, as taken by the tape. At *y* the distances from the previously determined points *i* and *k* are swung in with the dividers and the point *y* is established. The same obtains at *y. e.*, &c., &c.

It will readily be seen by the practical engineer how this method can be modified to suit two base lines, one on each side walk, when desirable. Also if profiles are desired how readily they can be taken on the base lines.

Regarding discrepancies, the greatest error allowed by me in surveys for the city of Charlestown, Mass., when Associate City Engineer, was one tenth of a foot in 1000 feet, but of course this must vary with circumstances.

Remarks on Hospital Construction.

BY JAMES R. WILLETT, ARCHITECT.

Our attention has been called to this subject by a report made to the governors of the New York Hospital, Feb. 1876, by a committee appointed for the purpose of examining the subject of Cottage Hospitals.

Although the subject of hospitals belongs to the domain of medicine, yet their design and construction appertains to the architect; besides the study of them is the study of sanitary science applied to buildings and cannot fail to be both interesting and instructive, not only to the architect, but to all intelligent men.

There is a mass of information contained in reports, transactions, etc., of various societies, and also in papers by medical men and others, which have been published during the last twenty-five years, and yet, for the most part, it is not readily accessible.

The opinions given are various and contradictory, nevertheless the opinion that small hospitals are the best, and that it is better to have them in the country close to a city rather than in the city itself, may be said to be established. We quote from the report mentioned:

"That in all the hospitals whose records have been preserved, it is found that, although the art of surgery has made great progress, no improvement in the cure of patients has been attained—the average mortality after operations remaining unchanged for thirty or forty years; and that in small and separate hospitals the mortality diminishes with the size of the building.

"In the treatment of disease the same rule holds true; the nearer the condition of the patient approaches that of a member of a well ordered household, the better are the chances of his recovery.

"The most successful hospital, therefore, will be a cottage, and the best general infirmary will be a village of such cottages, surrounded by gardens and not bare of trees. Pure air is the first necessity. Great cities have been supposed to require great hospitals in their midst, so as to receive the large number of sick and maimed persons who seemed likely to require instant rulief. In fact, however, it turns out that the patients who are produced by a great city are wonderfully few. * * *

"One of the most recent works on hospitals is a treatise on 'Hospitalism and the Causes of Death after Op-

erations,' published in 1874 by John Eric Erichsen, one of the most distinguished of living surgeons, and senior surgeon to University College Hospital, in London. 'I cannot but think (says he, page 91) there is some-'thing radically wrong in the conventional method of 'constructing ordinary hospitals. They are simply big 'houses with every floor filled with sick and injured peo-'ple. On the ground floor, accidents and operation 'cases; on the first floor probably medical patients; 'above, chronic surgical cases. Who can wonder at the 'development of pyœmia below and erysipelas above? 'Who would live in an ordinary house thus filled? Who 'would expect to preserve his health if he ventured to 'inhabit it?'

"There is a disease almost peculiar to large hospitals called pyœmia.'

"It causes the death of one third of all who expire after amputations for injury; and of those who have suffered amputation for disease, pyœmia destroys thirty-four per cent. So that it is not too much to say that one-third of all who die from the effects of amputations perish from a preventable cause. * * *

"In maternity or lying-in hospitals the danger to the inmates from a similar cause—puerperal fever—is frightful. Lefort, having compiled the results of two millions of cases of parturition, one-half at the homes of the women, the other half in lying-in asylums, found that:

At home, the deaths were	1 in	212
In hospitals "	1 in	32.

The risk being about seven times as great in the best managed institutions, as in the case of a woman who becomes a mother in the poorest habitation or garret."

In Sir James Simpson's work on Hospitalism (London, 1871) the following is given as the per cent. of deaths from amputations in British hospitals:

Metropolitan hosp'tls con'tng			300 to 500 beds,	41	pr. ct.
Provincial	"	"	201 to 300 "	29	"
"	"	"	101 to 200 "	28	"
"	"	"	26 to 100 "	18	"
"	"	"	25 and under	14	"
Private Country Practice				11	"

After the Crimean war Florence Nightingale called attention to the fact that large hospitals should not be located in cities, and by her "Notes on Hospitals" she greatly aided to improve both the construction and administration of hospitals, and to spread this knowledge among reading people; since then many others have examined and written on the subject.

The main difficulty appears to be that althogh patients may be cured of the disease which occasions them to come to the hospital, yet they contract other diseases there, known as "hospitalism" peculiar to hospitals, which are frequently fatal. It appears to be admitted by all medical men, even by those who advocate large hospitals, that hospital buildings become impregnated with poisonous matter, in course of time, so as to require a thorough stripping off of the plastering or other surface of the walls, and some argue that the whole building should be destroyed as the only effectual solution of the question. This idea is carried out in the marine hospital lately erected at San Francisco which is built of wood and intended to be destroyed at the end of ten or fifteen years. An account of this hospital is given in the report of U. S. Marine Hospital service for 1873, where it is stated that the estimated cost of this hospital is but $59,000 (in round numbers) whilst there has been an average cost of nearly $400,000 for every hospital now owned by the government, of equal capacity.

Another advantage claimed for this style of hospitals is, that they can be easily altered and improved in such ways as experience may dictate.

It is a fact that the wooden, one-story hospitals built by the government during the Rebellion, under the direction of the medical department, were very healthy and successful, so much so that one eminent physician has said that they had become models for the world.

Three out of the five physicians who made separate reports to the trustees of the John Hopkins Hospital recommend one-story pavillions, and as far as we can judge they give more cogent reasons than the two others do.

One of the reasons alleged for putting up hospitals in cities is that they may be readily accessible to students in the medical colleges, and convenient to the professors therein. This in itself is desirable, provided always that it is not injurious to the patients, but it would be a great abuse to risk the life of a human being for the convenience of any one.

For some years past there have been some hospitals built in England known as "cottage hospitals." They are simply what their name denotes, cottages, with from two to eight beds, though, owing to their success they are increasing in numbers. The intention is to have but few patients in each and to resemble as near as may be, a private residence specially adapted to the care of the sick. This idea has met with such success that it is proposed to construct a hospital with the wards consisting of cottages. This is what the report of the governors of the New York Hospital recommends.

"Rural hospitals are called Utopian. They are objected to because patients will not go so far from their friends; because physicians and surgeons will not visit them; because patients cannot bear the fatigue of transportation; because the administration will be too costly; because clinics for the instruction of students will be no longer possible.

"Those who have faith in cottage wards in the country, consider their advantages to be—that twice as many lives, at least, will be saved.

"—That the cost of land and buildings will be not more than one-tenth, perhaps one-twentieth, of a metropolitan hospital containing the same number of beds, so that the *rent*, as represented by the interest expended for land and buildings will be but a small fraction of the rent of a correspondingly capacious city institution; the amount saved fully paying for expensive administration;—that patients are likely to go willingly, with free passes, to a village within an hour or two of town, where their friends could visit them in the same way.

"—That consultations could be held with no greater loss of time than in the city, distance being no longer the difficulty, but time only.

"—That clinics would be held, free railway or steam boat passes being furnished to students who would throng to see the place where twice as many sick people recovered as in any city hospital, and to find out the reason why. A resident physician of first-rate ability would be always present, as in our asylum for the insane.

"The transportation of the sick could be in cots suspended with rubber elastic slings inside the ambulances, so securely that the patient need never feel a jolt. * * *

"There is nothing new in the cottage hospitals we recommend. Thirty years ago Sir James Y. Simpson had often taught that if 'our present hospitals were 'changed from being crowded palaces, with a layer of 'sick on each floor, into villages or cottages with one, or 'at most two patients in each room, a great saving of 'human life would be effected,' and he recommended at Belfast in 1876, that 'hospitals should be changed from 'wards into rooms, from stately mansions into simple 'cottages, from stone and marble palaces into wooden, 'brick or iron villages.'

"Dr MacLeod, of Glasgow, in 1869, predicted that the 'future hospital would consist of small buildings 'placed among fields and gardens, and having all the 'aids to recovery which amusements, flowers and music 'could contribute.' He advised small houses of relief, scattered through a large city in order to provide for urgent cases needing succor immediately after an accident, or taken suddenly ill, as in sunstroke. And he strongly condemned 'the present pile of courts and towers crowded into the heart of our great manufacturing 'cities, which forms the type of existing general hospitals.' * * * * * * * * *

"Your committee recommend that after the completion of the building now in process of erection, in Fifteenth street, and its inauguration as a hospital, the plan for establishing a village of cottage hospitals indicated in this report be carried into effect on such a moderate scale as would be sufficient to test its merits without interfering with the ability of the society of the New York Hospital to carry on its other operations."

The last paragraph is almost an admission that it was a mistake for the corporation to have built their large hospital on Fifteenth street at all. We are glad to see that so old and influential a corporation as the New York Hospital has taken steps to ascertain in a practical way the best system to be pursued.

There is an excellent paper in the report of the U. S. Marine Hospital service for 1873, by John M. Woodworth, Supervising Surgeon of the Marine Hospital service, in which much valuable information is compressed into a small space.

Dr. Parkes' "Practical Hygiene" should be in the hands of every architect. Wilson's "Hand Book of Hygiene" is also a good work. Galton's "Construction of Hospitals" is too well known to need special mention. There is also much to be learned from the reports on the Hygiene of the U. S. Army.

State Survey of New York.

The second meeting of the Board of Commissioners was held at the State Library on July 11th, to report on the method of conducting the State Survey. The following report we take from the *Albany Argus:*

All the members except Hon. Wm. A. Wheeler and ex-Gov. Seymour, were present, to wit, Messrs. Pruyn, Hale, Olmsted, Dorsheimer and Stout.

The Hon Isaac I. Hayes, being present, was invited to present his views relative to the survey, which he did at some length.

The committee appointed on the 31st of May last, consisting of Messrs. Stout, Hale and Olmsted, to report the best method for carrying out the requirements of the Legislature, submitted a report, which was accepted, and the following resolutions appended to the report were unanimously adopted:

1. Resolved, That an officer shall be appointed with the title of Director, whose duty it shall be to prepare and submit to the consideration of the Commission plans for conducting the survey, with estimates thereof, and under the direction of this Board to organize, superintend and manage the work required for carrying out such of these plans as shall be approved.

2. Resolved, That the Director shall nominate suitable assistants for the required duties of the survey and that none shall be appointed unless nominated by him.

3. Resolved, That the Director and all other officers shall hold office during the pleasure of the Board.

4. Resolved, That the salary of the Director shall be four thousand dollars per annum, including expenses.

Under the first resolution the Board proceeded to choose a director, and Prof. James T. Gardner, at present Secretary of the American Geographical Society was elected.

Manufacturing Notes.

A brass foundry has just been started in Rockford, Illinois.

Quite a number of English manufacturers have been visiting the iron works of Pittsburgh.

During the past two years the Iron Moulders' International Association disbursed over $16,000 for strikes, and paid $44,000 indebtedness.

The mill of Spang, Chalfant & Co., in Etna borough, Pittsburg, which was partially destroyed by fire yesterday, was the first pipe mill ever built west of the Allegheny mountains.

Porter, Bell & Co., of Pittsburg, lately shipped light locomotives to California, Washington Territory, South Carolina, Alabama, and are soon to ship others to Texas, New Orleans and Mississippi.

Twenty new passenger coaches were finished a few days ago at the shops of the Pittsburgh, Fort Wayne and Chicago Railroad Company in Allegheny, costing $4,600 each. They have been placed on the road and are now in service,

Messrs. Jones & Laughlins, of the American Iron Works, Pittsburgh, allowed their puddlers to go to work on the 6th inst., and we understand the seventy-five furnaces in this works will be operated double turn. The furnaces had been idle six weeks.

The California Mining Company on July 5th, shipped from the Consolidated Virginia assay office 136 bars of bullion, worth $522,655 75, and weighing seven tons and 1,810 pounds. This is the largest single shipment ever made by any company on the Comstock.

The Hartford foundry and machine company has just completed for the inventor, James Manes, Sr., of New Haven, a mammoth revolving furnace for treating ores, etc., principally gold and silver, and the machine will be tested in a few days with a ton of silver ore sent by Boston parties from their mine in Colorado.

There is said to be in the United States 252,148 manufacturing establishments, employing 2,053,996 hands, and producing annually $4,232,324,445 worth of goods. There are 40,191 steam engines, and 51,018 water wheels, with a combined force of 2,346,145 horse power.

The Lake Shore foundry of Cleveland, Ohio, is running with about two-thirds of a full force. An order for one hundred tons of gas pipe for Napanee, Ontario, has recently been filled. Shipments of water pipe for the Detroit Water works are made by lake as ordered on the contract for the current year made with that company,

Mr. Robert Napier, the famous shipbuilder, died on the 23d of June, at his residence in Glasgow, aged eighty-five. The history of his life was in great part that of the progress of marine engineering on the Clyde. His firm engined and built one of the first iron-clads ordered by the Government at the time of the Crimean war, and a number of other ships, including several Cunard liners.

Contractors' Intelligence.

Congress has appropriated $32,000 for the improvement of the Milwaukee harbor.

Alleghany City, Pa., wants cheaper gas, and the people propose to build new gas works.

It seems that the worn-out Nicolson pavements on the principal streets of Pittsburgh are to be replaced with stone and gravel.

The iron work for the new Point bridge is being delivered, and the frame work for the first span, between the abutment and pier on the Pittsburgh side, has been raised to position.

The contract for building the new Town Hall at Barnesville, W. Va., has been let to W. W. McCoy, of Marietta, for $7,990.

The work of cutting through the rock at the upper end of Tenth avenue, N. Y. City, which has been in progress for two years, is almost completed.

The contract for dredging the cove basin, Providence R. I., has been awarded to John B. Wood of Brooklyn and work will begin October 1st.

South Boston people, many of them at least, think the provision made for the 60,000 people in that district, by the proposed sewerage plan, to be entirely inadequate.

Bird and Bennett, sub-contractors on the New York and Canada railroad, have decamped with five or six thousand dollars belonging to workmen, boarding-house men and others.

The St. L., K. & N. R. Co. will raise its tracks between Keokuk and Hannibal above high water mark, so as to prevent in the future the delays and damages incito a wet season like the present one. The new line between Hannibal and Louisiana is already above high water mark.

Twenty car loads of granite have arrived from Somerset for the paving of the Diamond market square, Pittsburgh. The contract is under the management of S. R. Johnson & Co.

The 167 foot Span Iron arch, erected by the Clinton Bridge Co., of Clinton, Iowa, across the Iowa River at Steamboat Rock, Hardin Co., Iowa, was complete and opened for travel July 14th.

Messrs. Kelly & Jones of Pittsburgh, Pa., who have the contract for furnishing the new heating and ventilating apparatus for the Senate Chamber at Harrisburg, have commenced the work of removing the old heaters.

Work on the Keene end of the Manchester and Keene (N. H.) Railroad has commenced. E. L. Barrett of New York is the contractor for twelve miles of the western part, and expects to finish it before winter.

A new bridge is to be built across the Maumee, at Waterville; there will be six spans of 150 feet each, costing $50,000. The structure is to be of wood, for general travel. J. E. Strutton, of Toledo, is engineering the work.

A contract for grading and completing the gap of 45 miles between Lansing and Flint, Mich., on the Chicago & Lake Huron R., has been let to Clark Brothers of Chicago. The road is to be completed in time for the fall grain trade.

The Secretary of State has issued a certificate of incorporation to the St. Clair Manufacturing Company, of East St. Louis, Ill.; capital $100,000. The object is to manufacture cars. Also to the Pontiac & Eppard Joint Toll-way company, of Pontiac; capital $3,000.

At the letting at Moline,, Ill., July 6th, for building a Combination Bridge of 720 feet, across Rock River, bids were received from the Keystone, the American and the Clinton Bridge Co's. The contract was awarded to the Clinton Bridge Co., for their Howe Truss Combination Bridge, to be erected and open for travel in 90 days.

The Watson Manufacturing Company, to whom was awarded the contract for building the superstructure of the Congress avenue bridge over West river, at New Haven, Conn., are financially embarrassed and a Receiver has been appointed who has charge of the works. The superstructure will be finished according to the contract,by the Receiver, so that the town will not suffer any inconvenience from the embarrassment.

The contract for paving with Belgian blocks and curbing where necessary Baltimore street, from Green street to Harrison street, was awarded to John Haugh. The stone will be immediately ordered and the work begun as soon as possible. The Belgian pavement work on Second and South streets is in progress.

The Phœnix Iron Company of Pennsylvania, last week shipped an immense permanent bridge span, 307 feet in length. It is the largest continuous span that company has ever turned out, and is destined for the Philadelphia, Wilmington and Baltimore railroad bridge across the Susquehanna at Havre de Grace.

J Bentley & Son of Milwaukee are at present engaged upon the construction of the new Court House at Racine, Wis., for which they were awarded the contract some months since. The walls of the first story are up and by the terms of the contract Monroe Bentley & Son have two years time to finish the structure. The price is $40,000.

An iron bridge 40 feet long and 18 feet wide, with stone abutments, is to be built over Coon creek, near Clinton, DeWitt county, Ill. Appropriations for other bridges of iron and wood over the same creek and in the same county are asked for and will probably be granted. Bridge contractors will therefore do well to look the matter up.

Proposals were opened July 12th, for constructing a sewer along Pratt street Baltimore, from Howard street, where it will connect with the Liberty street sewer to the basin at Light-street wharf. The bidders were J Edward Kirby & Son, John P. Crowley, Pearl & Osborne, John H. Brady & Co., Lock & Chamberlain, John Moore, Michel Flynn, T. Conway, Thomas Coburn and A. Knoop & Patterson. The work will not cost the amount of the appropriation, $12,000.

The Baltimore harbor board, on July 12th, awarded the contract to cover between 200,000 and 300,000 cubic yards of excavation to Daniel Constantine, the lowest responsible bidder, at the rate of 10 cents per cubic yard, dumping inside of Sollers' flats, and 16½ cents per cubic yard, dumping at the 15-mile dump. There were seven bidders, including parties in New York, Philadelphia, Albany, Washington and Baltimore. The Baltimore city machines and scows will be used on the work, for which the contractor will pay the city at a rate already fixed by the board.

The new long iron span is about to be placed on the railroad bridge across the Susquehanna at Havre de Grace. The span will be 305 feet, or 50 feet longer than the one it is to replace. The piles have been sunk by the torpedo process through 90 feet of water and mud to a rocky bottom foundation. The placing of the piles was accomplished without difficulty by the torpedo process. Six of the thirteen spans have been replaced by iron, so that gradually all the wood work will be removed, when the great bridge will be transformed into one wholly of iron on granite piers.

A meeting of the City Council of Winona, Minn., have closed the contract with Messrs. Geo. C. Morgan & Co., of Chicago, for laying the new waterpipes for the waterworks. Some few changes were made in the size of the pipes. The specifications were agreed upon, and the pipe is to be laid as follows: 1,835 feet of twelve inch; 740 feet of ten inch; 1,185 feet of eight inch; 4,125 feet of six inch, and 116 feet of four inch, making a total of 8,001 feet of pipe and 17 hydrants. The contract price is $2,866.30. The contractors expect to begin operations next week, and, with fair weather, will have the pipe all laid and covered in about three weeks.

The city authorities of Baltimore, Md., July 12th awarded the contract for the repaving of Baltimore street, from Harrison to Greene streets, with Belgian blocks, to John Haugh, at $2.49½ per yard. The lowest bidder offered to do the work at $2.48, but failed to file the necessary bond. The work of repaving the street will be commenced forthwith. Mayor Latrobe has made an inspection of the Belgian blocks to be used for the repaving of Second street, and pronounced them to be of a supderior quality. The laying of the pavement is to be by the Camp process. The foundation of the pavement is subjected to a pressure of ten tons to the square foot, rendering it capable of resisting the weight of any load. It is impervious to water, and will not absorb liquid filth of any kind. It is surrounded with an elastic cement, making it comparatively noiseless. It is claimed that the stone will keep in good condition for twenty years. The city authorities state that they consider it a far better pavement than that laid in other portions of the city.

The Suez Canal.

At the meeting of the Shareholders of the Suez Canal Company, held in Paris, June 26th, three English Directors were elected to seats at the Board. The great event of the day was the declaration of a dividend on the share capital over and above all charges and interests prescribed by the statutes. The dividend, although a small one, amounting to not more than 1fr. 88c. per share, is an earnest of future earnings, and is obtained out of a surplus of upwards of one million of francs. The revenue for 1875 was estimated at about thirty-one millions of francs, and the expenses for the same year at about thirty millions of francs. The report which was read to the assembled body of Shareholders was passed in all its details, and M. de Lesseps congratulated the meeting at having at length vanquished all difficulties and entered upon a more assured future than heretofore. The most interesting part of the report—and which concerns the public as well as the Shareholders—is the evidence adduced of the performance of the works of the Canal. It was stated that the dredge at Port Said gives a less amount of clearances than duing the previous year, and it is inferred from this fact that the natural obstacles to the maintnance of the Canal in good working order at a minimum expenditure are gradually disappearing. It was likewise stated that the salt bed of the bitter lakes is gradually dissolving, and that in course of time this impediment to the navigation of the Suez Canal will have been vanquished. It will be recollected that one of the most persistent assertions of the opponents of M. de Lesseps' scheme of an intermarine canal was that it would gradually fill up, and that it could only be kept temporarily clear at a ruinous expense. M. de Lesseps has, however, lived to see not only political but natural obstacles melt away before his own dogged perseverance, and the steady improvement of the scientific aids at his disposal.—American Register.

Foundations of the New Opera House at Paris.

BY M. BAUDE.

From the Proceedings of the Institution of Civil Engineers.

The site of the new Opera House at Paris occupies an area of nearly 2¼ acres. The ground underneath the stage is excavated to a depth sufficient to permit the stage to be lowered in its entirety, together with its decorations, some of which reach a height of 50 feet. In order to render this portion of the building fit for the reception of the machinery and other theatrical appliances requiring to be kept perfectly dry, a well has been excavated at a still lower level, with arches to support the superstructure. The total depth from the street level to the bottom of the concrete is, except immediately below the stage, 18 feet. In the latter case it is 36 feet, and extends over an area of 2,475 feet. At first the excavation was carried on with facility, but as the depth increased, water was met with in large quantities, and the source traced to the hills of Belleville and Menilmontant. To obviate this difficulty a large cofferdam was constructed, consisting of a double row of timber piles, with beton between them. The piles were nearly 12 inches square, 21 feet in length, and driven down by a steam pile-engine to a firm stratum. An iron pile was used to pierce the ground previously to the driving of the timber. The space between the piles was then dredged out, and it was originally intended to fill it with liquid beton composed of mortar and flint stones, in the proportion of 3 parts of the former to 4 of the latter. The mortar itself consisted of 40 parts of lime, 15 parts of cement, and 100 parts of sand. To keep the water down eight pumps were set to work, and it was soon found that there was no necessity for using liquid beton, but that it could be laid solid and dry, which the Author considers a preferable arrangement.

The trenches having been excavated, the beton was spread over the whole surface to a depth of 6.5 feet, and carefully leveled. It was then covered with a layer of cement 2 inches in thickness. Another layer of beton was superimposed, and upon it the inverted arches were constructed which formed the curved surface of the well. The arches were built in this manner to better resist the upward pressure of the water, which, however, did not average more than one-half ton per square foot of surface. The walls of the gallery, the pillars supporting the well, and the massive walls carrying the stage, were built simultaneously. The well is surrounded by a gallery varying in breadth from 6.5 feet to 13 feet. It is by means of the exterior walls of this gallery that the water is kept out of the well, which is perfectly staunch, and fulfils its object in rendering the space below the stage a completely watertight compartment.

The pressure upon the lower courses of the great wall supporting the stage, which has a thickness at the base of 8 feet, is nearly 9 tons to the square foot, which is about double the usual allowance. But this is surpassed by the weight upon the small columns of Juca marble, which support three times the former pressure—an amount which numerous experiments have shown to be quite consistent with safety. In the foundations of the building there are 124,262 cubic yards of masonry, costing all round close upon 5 guineas the cubic yard. The greater portion of the stone was delivered on the site, ready to be at once placed in position, thus enabling the work to proceed with regularity and despatch.. T. C.

Shops and Shop Buildings.

BY J. W. CARPENTER,
Architect and Constructing Engineer, Springfield, Ohio.

To compute the extent of our manufactures, would be a task we would not like to undertake. To number our machine shops—next to impossible, and their growth so rapid—a census would be good but for a day, except as a rough computation. Yet how little we hear of the subject of this article, except as a piece of praise of some particular shop, or criticism of some fallen structure. Our building papers, mechanics' journals, and those whom we should expect to say what they know about it, seem to avoid the subject. It may be from a natural reticence, but more than likely from a want of knowledge as to what proper shop building is. There are many reasons for this. First, manufactories are locked up with secrets not for the public view, and "no admittance" closes the doors to general observers, thus hindering investigation as to their construction. Next, they are often built on the spur of the moment, four walls, roof and floors, with windows at random, or in military order, completes their picture, and it is not until after his first building has fallen into premature decay that the manufacturer looks around for a proper model; and where will he find it? He must furnish his own model—his builder improves on the previous one only by adding more walls, and the architect, if employed, puts in some more, and arranges the windows harmoniously; puts on a costly, fancy roof, like a school house or college, and then he has done his part; but ask the manufacturer if this is what he wants, even after he has built it? It may stand pretty well, but there are many buts to the thing. It is oftener than otherwise we hear of the structure being entirely unsuited to its purpose; the walls shaking, and the fancy roof ready for a tumble the first chance it gets. To avoid this a great number of manufacturers have built firm solid walls, using great excess of materials, spent money lavishly, and obtained a durable structure; but as to the how to do it, he is about as far off as any one, only he has by main strength mastered his object; but even then, he is not settled that he is all right.

The next reason is, that nearly every one thinks he knows all about it, and if he dont there are plenty of models to copy, and there the matter rests, until he gets the experience, when he goes to his corner. The next is, no attention is paid to its study by any one in particular, who is qualified, because of the want of proper remuneration for the services rendered. Our architects are, as a rule, unqualified, and are too fantastic in their elaborations to suit the manufacturer, who knows they must come down to solid ideas before they can be of any service to him, and are seldom employed.

Mr. Ryle, before building his great silk mills, waited upon me, and the first question was, "Do you understand the silk business? Upon answering him in the negative, he coolly took me down by saying, "I knew nothing about shop building." This remark showed me exactly how the bulk of our best manufacturers look upon architects, and avoid them because of a lack of sympathy with their business difficulties, and I knew it was the architect's fault, for it is seldom you find one who gives the subject the slightest thought, but upon explaining my duty to him would not be to show him what kind of shop he wanted, but how to build his wants properly, I received his consideration, and was permitted to put his ideas into shape. But this is the point here which I feel is wanted, not only that the owner should feel he has the proper man employed, but that the architect should know what the manufacturer wants, and should make his wants an especial study.

An architect, to be of use, must adapt himself to many things not in the theory of design; and be very familiar with the laws of construction. An architect may plan a pretty house, church, or public structure, or a *handsome* shop, and yet be totally unfitted to grasp the job of *building* a shop. It is often explained, "Oh, it is simple enough; all you have to do is to leave off the ornament." But our experienced manufacturers know better, and will avoid the man, well knowing it is strength, the proper adjustment of parts, with the symmetrical, substantial finish, that is wanted. Now to properly build a shop, an architect who understands this work, must be the personal superintendent of all the branches of the work. The workmen must not be allowed to make a single piece of bad work, or alteration; so he must be on the ground all the time, specially watchful. Details of construction must be elaborated very carefully, or errors which will destroy his building will creep in. It being the general idea among all mechanics, that they must suggest alterations, and that anything is good enough for a shop, ruins the work as it proceeds, and careful both in altering, and in putting in what they may most likely know nothing about, or may do at a pinch.

I have heard architects remark that "manufacturers were so close, and avoided the expense of building properly, and there was no use of trying to cater to them." My experience has been so different that I am at a loss to account for the unjust calumny. Manufacturers are the most willing class to pay for what they want and know to be right, I have ever met with—an experienced manufacturer cannot be fooled with a put off—a covered up the greatest difficulty is in having men working to understand that, as it is a shop, they must be particularly blemish. They are more careful, exacting for the right, and the most willing to learn and pay for their experience, feeling most acutely the limited store of examples they have to draw upon.

Where is the manufacturer who has no pride in his shops? Show me the man who does not watch every fault of construction, carefully repair weaknesses in his shops when developing, unless he is using it for a makeshift until he is able to get into permanent quarters, and I will show you the one who is an unsuccessful business man; one who neglects his customers and collaterals; but this is not the common case. No; the majority would sooner sleep on a straw bed, neglect home comforts, go without meals, than not have a good, substantial, and well arranged shop. And if there is any money to spend, you find them first looking the shop over, their comforts afterwards.

But the next question—how to build them? Plenty have the experience, and know what not to build, but this question is one that cannot be answered in a breath, and the emergencies for one will not often suit for any one of a hundred others. Proper appreciation of the business leads us to consider the general points, which must be used in all, and not to specialties belonging to specific kinds of business. The lighter the machinery often the greater the strength required; for instance, the vibratory motion of looms will throw a strong building which will be suitable for a large machine shop; reciprocating machinery will toss the walls off their foundations, which the heaviest weights and revolving machinery would not disturb. So it will be perceived that ponderous strength is not always the requisite; yet we see shops heavy enough for a bonded-warehouse, which shake like a reed, notwithstanding their strength.

But how to build is our theme. First, build walls of suitable strength for the weights; light walls properly balanced and bonded, hold more than ponderous walls full of bats; have the walls, as far as possible, thrown in panels, using pilasters under the parts bearing the roof trusses; strengthen all large piers in the same manner. Now it is usually accounted that walls with pilasters are just as strong without them; this is truly the fact, as far as the bearing of the weights and superstructure is concerned; but they break all vibratory motion. Ancient walls, eighteen feet thick, could be thrown with the battering ram, but what could throw the Greek form of the wall? it had to be knocked to pieces piece by piece. Offsetts of parts of the fronts are of great use, not only adding ornament, but are of the greatest value for stability. Avoid ornament for the sake of ornament, for it is a blemish; but construct for strength, and if it makes a pleasing feature, use it to the best advantage. This is for the general form of the building; but ties, both ways, to a shop, is as necessary at the walls, and can readily be arranged for in the tiers of beams.

Foundations, though not spoken of at first, are not the least part of a structure of this kind; should be built so the bearings are perfect on the best of bottom, and the upper walls to rest on the centers of the foundations, securing a batter both ways.

As to the roof and inner framing, it is far better to arrange to throw the weights to concentrated bearings than to scatter distribution, as this tends to break the effect of vibratory force. Beams may be thrown over long spans by trussing them, and this I invariably do; putting them good distances from centers, in couples, and bracing them. This distance is governed by the class of machinery, but the beams generally come directly under the bearers of the machine, and renders them solid, and keeps them perfectly level; but to have one side of a machine on a beam and the other between the beams. is very wearing to some machines, and they are never steady. Beams of this class seldom split, or settle, or vibrate when supporting machinery.

Another important item is the roof; this, if not balanced and supported on the walls properly, will produce vibration and bulging of the walls below, when in motion. Roofs are, as a usual thing, too heavy for the walls supporting them, and it is best to use as little timber as possible, and substitute iron wherever possible, it being cheaper and many times better.

I might lengthen the points to long articles, but hints are all that are possible in so small a space, and future writings will replace the loss in the present issue. The next important item is light.

Shops need to be well lighted and ventilated; the windows wide and long. I make it a rule to arrange the radii of light so that the machines in the center of shop will receive as much light as those near the windows, and care should be taken to attain this. The remark, "this is well lighted," by the superintendent of the works, shows his pleasure better than anything else. Dark shops spoil more mork and good workmen than any other evil.

As to arrangement, it is the great study of the shop builder to systematize the arrangements of shops; but it requires the ready perception, and such varied experience, that only the most careful study will attain it. It being presumed that this can be answered at once by many manufacturers, leads to some urgent requests from them for me to explain the best arrangement; but there are so many points in special manufactures to be considered, that several weeks or a month taken in elucidating the answer I consider a very short time. And when the manufacturer considers, he will see that it has taken him years to bring this problem to a favorable solution in his own mind, and then he will accept suggestions; for truly never was there a branch of study which so clearly shows that the more you learn about it the less you know; the more data you get to work from, the more confusion. When I hear the remark, "that shop is a substantial structure," then I know that the construction is apparent to the observer, and this is wanted in the great majority of our shops. A fancy structure seems a horror to look at, unless you can see through it the outlines of true construction; then those alone are far more beautiful in their varied outline than the most gorgeous display.

In our next we will consider the structure of foundations, and walls of buildings suitable for shops. Special inquiry as to specific points will be considered as they may appear.—*American Manufacturer.*

TECHNICAL EDUCATION.

Since our editorial on this subject of two weeks since, we have received the following communication from Mansfield Merriman, Sheffield Scientific School of Yale College:

NEW HAVEN, Conn., July 18, 1876.

I send you by this evening's mail a copy of the Programme of the Sheffield Scientific School. It may, perhaps, be interesting, in connection with the remarks on Technical Education in your last issue, to give an item concerning the conditions upon which the degree of Civil Engineering, is conferred at the eastern polytechnic schools. You will find on p. 19 and 20 of the programme, the manner in which they are conferred here.

We have looked over the catalogue sent, carefully, and that, with the above letter shall furnish the text of the following remarks. The field is broad, and one to which we may return at a future day and analyize the courses of our various technical schools; in the meantime, we shall leave the field open for any well tempered discussion.

The Sheffield Scientific School is intended for "graduates of this" (Yale,) "or of other colleges, and other persons qualified for advanced or special scientific study." A three years course is given, the first of which is entirely general in its natnre, the second and third being more particularly devoted to the specialty in view. On graduation. in Civil Engineering and also Dyamical Engineering, the degree of Ph. B. is given, a thesis on some specialty of engineering construction being required.

The degree of Civil Engineer or Dynamical Engineer is given after one or more years of post-graduate study coupled with practical experience on some constructive work. The course is well considered, and the character of the instructors guarantees the requisite thoroughness. The post-graduate course is but a repetition of the under-graduate course on a somewhat heavier scale.

Taking the course as a whole, we are not aware that the requirements for an engineering degree at Sheffield, are any more severe than at several other eastern institutions, among which, as of long standing, may be mentioned the Rensselaer Polytechnic Institute at Troy, the Boston School of Technology, the Columbia School of Mines of New York City, or the Stevens Institute of Mechanical Engineering at Hoboken, N. J. Cornell University and one or two other schools also give the degree of C. E., after one or more years of post-graduate study and practice.

The post-graduate requirement for a degree is a move in the right direction and one that the eastern schools are fast adopting, but we are not informed that it has, as yet, made any advance this side of the Alleghany Mountains. One of these schools which spend a large part of their substance in marking out paper courses in unabridged catalogues, will soliloquize thus—— "Buncombe University is giving the degree of C. E., and if we do not give it ourselves, all our students will leave for some place where they can get the most for their money." Competition may be a good thing, but in this western country, with the money element of an education pre-eminent and its attendant demoralization, and a "University" on every cross-roads, the inference which may be drawn seldom belies the facts. While we do not desire to draw invidious comparisons the facts should be known, and every engineer of prominence should interest himself in their solution.

On their proper solution there is much room for an honest difference of opinion. Nothwithstanding the method adopted in giving degrees by some of the eastern schools, the whole system is radically at fault. C. E. is the higest degree given to a Civil Engineer, and should be a certificate ot ability and eminence, not to be left off the names of our first engineers, instead of a badge of graduation from some technical school which is the only significance that can be attached to it at present.

The American Society of Civil Engineers and its sister societies already include sufficient of our best talent to secure a better system, and one which shall command respectful support. We submit that there is nothing which would farther conserve the true dignity of the profession for all future time than the establishment of a kind of court or board, before which every engineer who designs to practice other than in a subordinate capacity, shall stand the test imposed by fathers in the profession. Such an arrangement would put the technical graduate, the "self made" man, and also the various technical schools themselves, on the same plane.

Such a board might be difficult to establish without legislative enactment; but concerted action on the part of the societies, persistently adhered to, notwithstanding the opposition which it would inevitably provoke, we believe would meet the approval of our candid, thinking men.

THIS question of technical education may contain the germ of the ill feeling which, from time to time, breaks out into a controversy between the Government and the Civil Engineers. The ground on which such a controversy may rest is ably discussed by Dr. Whitney in the July and October numbers of the North American Review, for 1875, and also in the reply by Capt. Chas. W. Raymond, in the Galaxy for Jan. 1875. The merits of the question were summed up in No. 2, of ENGINEERING NEWS, and we do not desire to reopen that particular phase of the question. The time is in the recollection of most of our readers when a theoretical engineer, or one educated to his profession, was despised as a visionary individual, and one of no practical good to the community. At that time, and to within a very recent period, the Engineer Corps and the other graduates of West Point who had given up their commissions, constituted the main body of educated or scientific engineers. But with the advances which have taken place in the profession, the Engineer Corps has notwithstanding, preserved the attitude towards the Civil Engineers at large in which, at a former time, it was justified. Probably no greater misfortune could befall the country than to have the Engineer Corps shorn of any of its essential functions, for certainly it would not be possible to organize a more efficient body of men under any other department of the government, or in any other way, or one to which the *responsibility* for the success or failure of any engineering work can be more directly attached.

This question of *responsibility* is one of vital importance and to be borne in mind in all discussions on this subject. Aside from the question, that the Department has been grasping in its endeavors to obtain control of certain surveys, the ill feeling engendered has been in very bad taste. and to be deprecated by every sober minded man as a misfortune to either party to the controversy. We have no sympathy with an engineer, at present of considerable reputation, who in his endeavors to secure a great contract, sent letters to many of our best engineers asking them to unite with him in his antagonism toward the Engineer Corps, in regard to a problem they had not specifically studied and about which they could have but the most general opinion. It was manifest good sense on their part not to be drawn into such a controversy, especially as the issue was a doubtful one, in which the ablest of men might well differ, and which could only be settled *definitely* by actual experiment.

CAPT. EADS AND THE U. S. ENGINEERS.

As to whether or not the South Pass jetties are to succeed seems a more open question than ever before. There is still ample room for a difference of opinion as to their ultimate success, and in that regard we shall not express one; but one phase of the question calls for comment. We think that Mr. Eads has very much prejudiced his cause before the people in his late unfortunate and wholly unnecessary attack on Maj. Howell, and indirectly on Gen. Humphreys. We do not say that the attack was entirely unprovoked, but if the glowing accounts of the success of the jetties which were thrown broadcast through the land were true, Mr. Eads could well afford to wait a few weeks at least, to see his "enemies" discomfited by the facts themselves, notwithstanding the sudden fall of jetty stock.

To understand the merits of the question it is necessary to go back a little. It is well known that Gen. Humphreys and many officers of the Engineer Corps, including Maj. Howell, opposed the jetty plan as ill-adapted to the mouth of the Mississippi. Mr. Eads, in his not always courteous and well tempered advocacy of the scheme, had the support of many eminent men, among whom may be mentioned Col. Barnard and W. Milnor Roberts. A commission of most able men was called to consider the question, among whom was Sir Chas. Hartley, the engineer of the improvement of the Sulina mouth of the Danube. Thus far Mr. Eads had certainly great moral support from the best of engineers, and after lobbying at Washington for some months, succeeded in getting his bill through Congress.

Gen. Humphreys subsequently chose to put himself on record in four jetty papers or memoranda, containing the facts on which he based his conclusions. This was an eminently proper thing for him to do, as his professional reputation as chief of the Engineer Corps was at stake, and it was due to himself and the country that his views should be known beyond cavil. Yet Mr. Eads never seems to refer to them in well tempered language, and denounces their author and those associated with him, with attempting to thwart his designs, notwithstanding his bill has passed Congress, and the money, as was given out, has been secured.

The truth is, Mr. Eads would like very much to be regarded as a great public benefactor, instead of a simple contractor for a public work, in which the risk is great, it is true, but which with success, will be enormously profitable. We are not aware that he has claims upon public consideration that are to be respected above those of any other contractor for a difficult work.

Neither are we aware that it is a proper thing for the Secretary of War to close every official lip except that of Maj. Comstock, who, by the Secretary, is compelled to perform the duties of a contractor's engineer, to be subject to Mr. Eads' orders, and to report, not to the head of the Engineer Corps, as hitherto, but directly to the Secretary of War himself, who is supposed to be an expert in river hydraulics. [The letter of the Sec. of War will be found in another column.]

Without going into a fine analysis of official propriety, we submit that it was eminently proper for Maj. Howell to have an opinion of his own, and the charge of a series of surveys and studies of the various passes of the river for several years, would certainly qualify him to interpret a map of great elaborateness, comprehending the whole regimen of the passes, fully as intelligently as Mr. Eads could from his limited surveys. Now, has Maj. Howell a right to allow civilians to come into his office and examine these maps? Would he have a right to express an opinion? Be that as it may, reports, which soon grew into the proportions of most "malicious falsehoods," somehow went abroad, and forthwith Mr. Eads commenced to write letters in various directions implying very unbecoming conduct on the part of Maj. Howell. This very naturally drew forth a reply from that officer, in which he asserted many things as facts, of a very disagreeable nature to jetty advocates, producing an impression in many minds quite different from that formerly prevailing. This letter also contained some ill-advised passages which probably it might have been better to omit. At this point Mr. Eads applied to the Sec. of War, to have the surveys and studies previously referred to at the mouth of the river, so far as they involved South Pass, stopped; that no surveys or reports whatever, be made except by the inspecting officer; that the inspecting officer be required to report the results of his work or conclusions to Mr. Eads, on demand, and that he make his official report to the Sec. of War only, with the exception of Capt. Eads.

This seems a very strange appeal for a man of Mr. Eads' reputation to make, and stranger still, that the Sec. of War should prostitute his position at the behest of a public contractor, or even consider a request implying such burning insult to the Chief of Engineers; and yet, it was granted in full.

It certainly has a bad look, happening as it does but a few days before Mr. Eads' conference with the House Committee in regard to that first installment.

How has it all turned out? Fortunately, in the mean time, Maj. Comstock has made his report, and no one certainly can accuse him of any dishonest purpose. We find from the report now before us, that the "malicious falsehoods" of Maj. Howell were considerably more than half true, and were Maj. Comstock's surveys as comprehensive as Maj. Howell's, the inference is natural that many more of his "assertions" would prove not wholly "malicious falsehoods."

We think that the "Captain" has made a mistake this time, and such a one as to prejudice thinking men against the honesty of the scheme. It is hard to resist the conclusion that there is not a screw loose somewhere. Still, it may yet all prove to be due to the "malicious" and wily scheming of the Government Engineers.

THE DARIEN CANAL.

From time to time this project is revived,and we think it well to keep it prominently before the people, as no scheme, in all probability, would do so much to assure the supremacy of America on this continent. What the Suez Canal is to England and the Indies, the Darien Canal would be to the United States and the South American republics on the western coast. It would also secure,to a great extent, our supremacy in the commerce of the Pacific, which, situated as we are, naturally belongs to us. Several surveys have been made since the war, chiefly by Commander Selfridge, of what is supposed to be all the available routes. In no place was a location found suitable for a through cut from ocean to ocean, except at an enormous expense. All the plans presented contemplate the use of locks, and also a tunnel, the cost to be about $100,000,000.

Commander Selfridge thinks he has examined all the available routes. Since then there has been a report, which,however, has not been confirmed, that the agents of the Columbian government have discovered a pass, much lower than any yet examined, and one entirely feasible for a through cut. Lately, a convention of eminent scientific gentlemen, among whom was M. Ferdinand de Lesseps, met in Paris for the purpose of forming an International Committee to aid in the furtherance of this scheme. Relations have been established with the the leading geographical societies all over the world, and our government has signified its hearty sympathy with the committee. Many of its members believe that there is a portion of the Isthmus which has been overlooked, and which they believe contains the long-sought-for passage. However, it may be as illusory as the Caledonian Route so persistently advocated by Dr. Cullom, as one entirely feasible for a through cut at moderate expense, and yet which proved on survey to be quite impracticable. One hundrd millions of dollars, or even more, is not too much to pay for the canal in any shape, and certainly, no stone should be left unturned for its accomplishment. The Suez Canal, which was denounced by English engineers as totally impracticable and certain to involve financial failure, has proved a paying investment. So in our own case the traffic receipts of such a canal would probably exceed our most sanguine expectations, and even if it should fail in a financial point of view, there are reasons of state which demand it.

We think that the preliminary surveys, largely in the nature of reconnaisances,have gone far enough to warrant the government in instituting, with the co-operation of the Columbian government, a topographical survey of the whole Isthmus, of sufficient minuteness to determine to a certainty the most economical and feasible line. A few millions would not be too much to pay for it, and probably would be more than compensated by the increased economy of the line, finally adopted.

IN OUR last issue we alluded to the obstruction to navigation of the Mississippi River, caused by the numerous bridges which span it. We have learned since, that a commission of engineers met in St. Louis during last week, for the purpose of considering remedies for the evil, convened by the following order from Headquarters Corps of Engineers, which explains itself:

WASHINGTON, D. C., June 22, 1876.

By authority of the Secretary of War, a board of engineer officers, to consist of Col. J. N. Macomb, Col. J. H. Simpson, Maj. F. M. Farquhar, Maj. C. R. Suter, and C. J. Allen, will assemble at St. Louis, Mo., on the 7th day of July, 1876, or as soon thereafter as practicable, to inquire into the expediency of causing sheer-booms to be placed on the upper end of all or any bridge piers on the Mississppi River for the better security and convenience of navigation for rafts and timber, and will make special reports in each case, as provided by act of Congress of March 5, 1875. By command of Brig. Gen. Humphreys. THOS. LINCOLN CASEY,
Lieut. Col. of Engineers

The inquiry will include all the bridges from St. Louis to St. Paul. Not the least among these obstructions is the St. Louis Bridge. Although a noble arch bridge of three 500 feet spans, admirably adapted for crossing mountain chasms or any place where headway is not an object, it proves a great obstruction to navigation not only from insufficient headway at the crown, but from the fact, that, for purposes of steamboat navigation the arch diminishes the available span of sufficient hight for up-river boats to comparatively narrow dimensions, and most of the lower-river boats are utterly precluded from passing. The rivermen have just cause for grumbling, and the projectors have no cause for complaint to the recommendation of an officer of engineers, to build a canal around the bridge through East St. Louis and put in a draw. Now that the mists raised over what was really a great engineering feat, in a constructive point of view, have cleared away, it is seen that the plan recommended be the thirty engineers convened in St. Louis to consider "plans for a railway and highway bridge," would have been much better for all concerned. If the bridge was to be built to-day, it would, probably, be constructed in two spans on the Fidler type of rigid chain suspension bridge, similar in most respects to the Point Bridge, now being erected by the American Bridge Co., at Pittsburgh.

THE result of the complaints that the work on the dam to replace the one at Lynde Brook reservoir, Worcester water-works, which gave way last spring, was not being done in a thorough manner is that the Worcester county commissioners, after a hearing of interested parties and a visit to the dam, have, with the consent of all parties, appointed George Crompton and Albert Curtis, of Worcester, and Charles P. Whitin of Northbridge, a commission to examine the work and to execise a general supervision from this time. It is said to be generally acknowledged that the portion of the foundation under the pipe wall is faulty. This was the weak spot which caused the failure of the old dam, and it will now probably receive particular attention. It is very surprising that the work put in to replace the old dam should not have been carefully looked after, and even the slightest ground for suspicion and complaint avoided.

A COMPARISON of the weight and cost of a passenger train on the Eastern, standard gauge, and on the Boston, Revere Beach and Lynn Railroad, narrow gauge, respectively, has been made. These two roads run nearly side by side and the carrying capacity of the two trains is practically the same. The heavy Pullman car is a disadvantage to the Eastern road in the comparison, as is also the baggage car which is not required on the short line. A locomotive, baggage car, Pullman car and four passenger cars on the Eastern road give capacity for 230 passengers, weigh 138 tons and cost $63,000; one locomotive and six passenger cars on the Revere Beach and Lynn road give capacity for 272 passengers, weigh 58 tons and cost $18,000.

ECONOMY IN PUBLIC WORKS.

June 12th the City Council of Chicago passed an ordinance in regard to lettings, in which it was provided that the city should have the *privilege* of paying for work done, when it should be in *condition* to pay; very definite and satisfactory, we should judge, to contractors, and quite apt to result in low bids.

July 19th, bids were opened for improving the intersections of West Polk St., Sedgwick St., West Lake St. and Fulton St. The work was awarded at the following prices.

West Polk St. - Curb, 65 cts. per lineal foot; filling, 40 cts. per cu. yard; paving $1.40 per sq. yard.

Sedgwick St. Curb, 70 cts. per lineal foot; grading and paving, $1.40 per sq. yard.

Fulton St. Curb, 75 cts. per lineal foot; grading and paving, $1.30 per sq. yard.

The Board of Public Works rejected a bid from a perfectly responsible party in which the prices were fully fifty per cent. lower than those which were accepted, on the plea of *informalty*. The following are the prices in the *informal* bid.

West Polk St. Curb. 65 cts. per lineal foot; filling, 25 cts. per cu. yard; paving, 90 cts. per sq. yard.

Sedgwick St. Curb, 65 cts. per lineal foot; grading, 10 cts. per cu. yard; paving, 90 cts. per sq. yard.

Fulton St. Curb, 65 cts. per lineal foot; grading, 10 cts. per cu. yard; paving, 90 cts. per sq. yard.

This bid was to bear interest at seven per cent. per annum from the time the work was completed until paid, thus conceding to the city the *privilege* asked for, and yet the bid was rejected on the ground of informality.

Inasmuch as it is an open question as to who is to decide when the city is in *condition* to pay, and as the improvements must be paid for out of the taxes of '76 when collected, appropriations having been made for that purpose, it is a fair inference that the city can be made to pay within a year.

The sum of it all is this: The city is paying 50 per cent., with the additional privilege of a possible first-class law-suit, for the use of money which it can obtain at 7 per cent.

The cost of street intersections is fully one-fourth that of all the paving done in the city. As to the business principles, etc., involved, we leave the reader to draw his own inferences.

METEOR.

Prof. Colbert, combining the observations given in ENGINEETING NEWS of two weeks since with his previous notes, has recalculated the path of the meteor of July 8th. He finds his former conclusions, given in our previous article, to be, in the main, correct. In the *Tribune* of Saturday last he has written an elaborate article in which he states that the motion of the meteor was so nearly destroyed by the earth's atmosphere and attraction, that it is now passing in a nearly direct line toward the sun which it will reach in sixty-six days at a velocity of about 379 miles per second, either to be precipitated upon its surface, or revolve about it in a very narrow orbit whose aphelion will be very near the earth's path; so we may expect to meet our visitor again one of these days, and, in all probability, to remain with us permanently.

HIGH WATER OF LAKE MICHIGAN.

Much has been said in the past few days about the unusually high water of Lake Michigan. Last week we alluded to apprehensions felt at Grand Crossing and South Chicago. We have also heard much complaint from the suburnam towns on the west shore of Lake Michigan.

Formerly, the shore from Lincoln Park to Milwaukee was rapidly wearing away. This took place with the greatest rapidity at Kenosha, Wis., and just above Grosse Point Light House, where it amounted to from 12′ to 20′ per annum. Since these shores have become the sites of suburnam towns they have been protected by spur dykes or jetties of crib-work, filled with stone from 50′ to 100′ in length,usually thrown out at right angles to the shore. These stopped the littoral-current, forming a fine beach of sand and gravel above each jetty from 20′ to 50′ wide, which effectually protected the bluffs of sand and clay. At present, the water has in most cases overtopped these jetties, especially in a north east storm, and is rapidly wearing away the banks. Should the high water continue for several months as is not unlikely, these jetties will have to be raised at an expense of many thousand dollars in the aggregate or property owners must pocket the loss of much valuable real estate.

ELEVATION OF LAKE MICHIGAN FROM 1854 TO 1875, INCLUSIVE.

Year.	Max.	Min.	Mean	Greatest monthly mean.	Least monthly mean.
1854			1.83	May& June2.58	Dec. 1.02
1855	3.45	0.15	1.56	September.2.07	Jan. 0.76
1856	3.05	0.42	1.60	May & July1.99	Dec. 1.20
1857	4.35	0.60	2.42	August 3.14	Jan. 1.00
1858	4.69	1.33	2.90	Nov. 3.86	March 1.85
1859	4.45	1.31	2.08	July 3.90	Jan. 2.27
1860	3.53	1.30	2.54	July 2.91	Dec 1.55
1861	4.40	0.90	2.56	August 3.86	Jan. 1.73
1862	3.30	1.20	2.50	June 2.90	Dec. 2.00
1863	3.30	0.70	2.10	June & July2.40	Dec. 1.70
1864	2.80	-.80	1.57	May 2.05	Dec. 0.70
1865	3.66	-.40	1.30	August 2.02	Jan. 0.40
1866	2.50	-1.80	1.07	August 1.60	Feb. 0.37
1867	2.60	0.00	1.49	July 2.08	Jan & Nov.1.08
1868	2.58	-.41	1.01	June & July1.55	Dec. 0.41
1869	2.13	-1.00	1.13	August 1.83	Jan. 0.25
1870	3.25	0.41	2.09	June & July2.58	Jan. 1.25
1871	2.80	-.30	1.77	July 2.50	Dec. 0.75
1872	1.80	-.40	0.81	August 1.28	Dec. 0.29
1873	2.70	-.76	1.40	August 2.07	Feb. 0.37
1874	2.80	-.20	1.67	August 2.21	Dec. 0.72
1875	2.90	-.90	1.41	August 2.04	Feb. 0.59
	4.69	-1.80	1.805	3.90	0.25

ELEVATION OF LAKE, 1876.

Month.	Max.	Min.	Mean
January	1.80	0.60	1.26
February	2.50	0.40	1.55
March	2.83	1.30	1.87
April	2.90	1.37	1.92
May	3.59	1.90	2.68
June	3.59	2.60	3.05
July (1-10)	3.70	2.80	3.40
July (11-20)	4.20	3.20	3.54
July (21-28)	3.57	3.17	3.38

By examining the tables annexed, it will be seen that the water has risen quite rapidly since the first of May, at which time it stood at about at the average May hight for many years. The rapidity of the rise is not at all unprecedented being about the same as for 1857—8—9. The average hight for the past ten days 3.54, was exceeded by the monthly mean of Nov., 1858, July, 1859

and August, 1861. Wind has affected the readings as much as two feet either way from the monthly means, but this variation is seldom of long continuance.

The greatest difference in the monthly means (July '59, and Jan. '69,) in the past 22 years is 3.65.

The maximum variation in the lake level in that time is 6.49 ft.

The gauge from which these observations have been taken is situated in the North Branch of the Chicago River, somewhat over a mile from the lake. Its readings have been compared with gauges placed at Bridgeport, the mouth of the river, the Pumping Works and at Hyde Park, and no material difference in their readings have been noted except that the river gauge is less affected by wind than those on the lake front.

At a future time we shall analyze the various phenomena connected with the fluctuation of the lake surface.

THE above was intended for our last weeks issue but was crowded out. Since then we have collected the readings for the past eight days the results of which have been added to the table. Taking the mean for this time, 3.38, and comparing it with the mean for July. 1—10, and 11—20, it appears that the lake has reached its maximum height and is now falling. The maximum for July, thus far, is 4.20; minimum, 2.80, and mean, 3.44. It may be well to state that the readings are taken at 7 A. M., 12 M. and 5 P. M. On July 22, the readings were 2.9, 3.8 and 4.0. In the morning a stiff breeze blew from the S. W. which wheeled around during the day into the N. E. blowing quite a gale from that quarter. Between 3 and 4 P. M. the gauge read 4.6, the highest recorded in the past 22 years, except in 1858.

COOK COUNTY COURT HOUSE AND THE CITY HALL.

We have had the pleasure of examining the compromise plans of the architects, J. J. Egan, and Thos. Tilley, for the combined County Court House and City Hall the county part of which is now in process of erection on the old court-house site which occupies an entire block, fronting on Randolph, Clark, Washington and La Salle streets. This building will really consist of two buildings separated by an open court 62 feet in width but joined at the facade on each side by an arch 78 feet high and 30 feet span. Midway in this court, in the center of the quadrangle formed by the two buildings, rises the dome, as distinct as may be from the buildings themselves.

The entire structure outside will have the appearance of a single building, 338 feet long, 280 feet wide and 128 feet high from the court level to the balustrade. The several porticos are supported by 92 main colums 35 feet high and 3 feet 6 inches in diameter. The whole building will be surmounted by the dome springing from the court level, and rising to a height of 366 feet. This will be the third highest dome in the world; St. Peters, Rome, 450 feet high, being the first, and St. Paul, London, 380 feet high, being the second. The dome will be 85 feet outside diameter The interior will be 55 feet in diameter and 222 feet clear hight above the court level. There will be also four smaller domes, 188 feet high. There will be four main stories and basement. The porticos reach to a hight of two stories; the arch, before mentioned, three stories, an arcade over this arch connecting the libraries in the fourth stories of the two buildings.

The entire cost of the building is estimated at $3,300,000 and probably it can be built for less.

In the county part of the building 5000 piles have been driven for the foundations, and the basement story is up to the curb on the Randolph street front. The pile foundations for the dome are also in. Nothing farther than the excavation has been done to the city portion; the city has finally decided to accept the compromise plans for their portion of the building, but have not seen their way clear, as yet, to the money part of the problem.

Lemont limestone has been put in the basement story. The stone for the main building has not yet been decided upon. According to the *Chicago Times* the County Commissioners are at present taking free rides about the country, at stone contractors' expense, to examine various building materials. It is hoped that the free lunches, etc., which the above paper alludes to, will help them to an early decision.

NOTES.

An appropriation for the Keokuk canal is wanted.

Houston, Texas, is agitating the subject of water works.

A signal service station is to be established on the summit of Greylock, near South Adams, Mass.

Geo. D. Ansley, late Assistant City Sur. of Montreal, Canada, has received the appointment of City Surveyor of that city.

A set of wheels was lately taken from the baggage-car of the California and Oregon express train, which had run 91,800 miles.

About $167,000 of the bonds of the Mystic, Mass. water works have been canceled, from the profits of the works the past year.

Workmen are engaged in putting up the iron framework for the new Delaware, Lackawanna and Western Railroad bridge across the Hackensack River at West End.

The stone work of the new canal lock, in Cleveland, Ohio, is completed, and it only remains to construct and hang the gates and sluices. The entire work will be finished in a few weeks.

Within the past week a company has been formed at Janesville, Wis., and part of the stock subscribed for the purpose of building water-works. If sufficient encouragement is given the work will be begun at once.

The building of the temporary foot bridge for the use of the workmen in erecting the main cables of the Brooklyn bridge has been delayed until the decision of the United States Court is given, in regard to the injunction now pending.

There is a project afoot for crossing the Delaware River from Philadelphia to Camden, by means of a combined bridge and tunnel, the bridge to be thrown across the shallow portion of the river, the channel being crossed by a subaqueous tunnel.

Public services in memory of the late John A. Roebling, the engineer of the Brooklyn bridge, were held at Mulhausen, Thuringia, in Austria, his native place, June 11. A public lecture was given on his life and services, and a memorial plate was unveiled.

The reduction in the sundry civil bill by Congress, promises to interfere seriously with the work on the new Chicago Custom House. Up to June 1. the building (exclusive of site) had cost $2,400,000.00. The total cost of the iron work will be over $600,000.00.

The Mississippi River is said to discharge 28,188,083,892 cubic feet of sediment annually. One cubic mile is formed in five years and eighty-one days. The quantity annually discharged is sufficient to cover a township five miles square with a layer of mud forty feet thick.

Captain Eads explained to the House Committe on Commerce, July 19. the progress made in his jetty work at the mouth of the Mississippi, and showed that the work was complete and that he was successful so far, with every circumstance and prospect in his favor.

The wind accompanying the severe shower of Friday July 14. was so violent that the bridge spanning the Androscoggin at Turner Centre, Mass., over 300 feet in length, was blown from its piers and landed in the river. The wind blew a tornado, unroofing buildings, leveling trees, and causing a good deal of damage to the growing crops.

It was announced in Oshkosh on July 27, that the locks on the Lower Fox River improvement at Little Chute and Appleton will be soon completed, and that the river will be permanently opened for navigation between that city and Green Bay early in September. There is some work to be done upon the dam, but the engineers give the assurance that there will be no occasion to close navigation at any time on account of the dam.

After a long and vexatious litigation the tunnel company, who proposed to build a tunnel under the Hudson River from Jersey City to New York, in order to obviate the ferriage of freight and passengers between the two cities, have gained a substantial victory in the courts, the injunction against their proceeding farther having been dissolved. This decision will enable the company to prosecute their work for a considerable distance, which will be done immediately. More injunctions, are undoubtedly in store for them, but there is no doubt but that the tunnel will ultimately be built.

The new long iron span is about to be placed on the railroad bridge across the Susquehanna at Havre de Grace. The span will be 305 feet, or 50 feet longer than the one it is to replace. The piles have been sunk by the torpedo process through 90 feet of water and mud to a rock bottom. The placing of the piles was accomplished without difficulty. Six of the thirteen spans have been replaced by iron, so that gradually all the wood work will be removed, when the great bridge will be transformed into one wholly of iron on granite piers.

We learn from the Detroit *Free Press* that work on the harbor of refuge at Sand Beach is progressing rapidly. Cribs are now being built and sunk at the rate of one per week. During the present season seven cribs have been put in place. It is understood that the present contract contemplates the building and putting in place of fourteen cribs, and at the present rate it will be finished early in September. At the close of the season's work there will be about 4,000 lineal feet of breakwater in place, the last 900 feet of which will be without superstructure. The incomplete portion will enclose some of the best anchorage of the entire harbor, and will break the sea so perfectly as to be available at once for sailing craft.

The Water Commissioners of Detroit met July 19, to consider plans for a stand-pipe to the new Hamtramck Water works. The plans were prepared by architect, Joseph E. Sparks. The foundations begin 17 feet below grade, and are 50 feet across. The base is of stone octagonal in form; 40 feet above ground, the shaft assumes a circular form, 30 feet in diameter, the wall being 3 feet thick; at the top the tower it is 12 feet in diameter, the wall being 16 inches thick. This portion is of brick. The whole is surmounted by a gothic turret about 20 feet high, making the entire hight of structure 138 feet, or to the top of the flag staff, 160 feet. The stand-pipe proper will be 118 feet high, 5 feet in diameter at the base, taping to 40 inches at the top. A circular stairway gives access to the top of the tower.

The work of completing the Southern Maryland Railroad has been begun with energy. A large amount of work was done before and after the panic of 1873. The Company suspended work two years ago, but have now placed the whole line from Washington City to Point Lookout, at the confluence of the Potomac River and the Chesapeake, under contract to be completed for operation by Jan. 1, 1877. By the completion of this line, in connection with a line of steamers which the Company will put on from Point Lookout to Norfolk, passengers can be placed in Baltimore and Washington six hours earlier than at the present time, and in New York in the time now required from Norfolk to Washington or Baltimore.

We learn from a Detroit paper that the Detroit Board of Public Works have been investigating the pavement question and as the result of numerous experiments, they are free to state that they look upon the cedar blocks as the most economical pavement that can be laid. The stone gutters are laid because the city has the material, and the roughness on that part of the street does not effect the general traffic. Every street that is newly paved is laid with either all cedar or else with stone gutters and cedar blocks. Of all the prominent avenues leading into the Campus Martius, at Detroit, only one is paved with stone. That one is Michigan avenue, the worst business thoroughfare in the city, and it is simply the worst because of the pavement that is on it. Teams coming to the city will not travel it; the citizens will not drive their horses and carriages over it. and business men of any means will not locate upon it, because but little trade is done there. Even pedestrians avoid it as the dirtiest street in the city, the cobblestone being of such a nature that it is impossible to clean it, and a petition signed by nearly every property holder on the avenue has recently gone in to the Council asking for its repaving with wood Real estate on adjoining streets in Detroit, where one is paved with cedar blocks and the other with stone, shows a difference of 33⅓ per cent. in its saleable value in favor of the cedar blocks.

Engineering Field Work.

Written for Engineering News.

I.

At no time in the past has the subject of economical management of business been of more importance than at present, and in common with other occupations, the profession of Engineering, hard pressed even for existence, demands the most carefnl administration of its affairs to make it remunerative.

Among the details of his professional labors none are more puzzeling to the young engineer than the field work, presenting as it does ever fresh problems to the mind, varying them with every new locality, and with every objective result.

Different classes of work require different methods, different instruments, and too often, unfortunately, different men for the satisfactory execution of the field work connected with them. It is intended that the striking points of resemblance and of difference shall be indicated in this article and some of the more prominent difficulties discusssed.

In the first place the different kinds of work do not all require the same degree of accuracy; we have known men so unfortunately constituted that they were unable to recognize this truth, and we have heard of an engineer who, in laying out a tract of land he had just purchased in the mountains, used cambric needles for centres of stakes. We have, ourselves, no use for such assistants; accuracy is absolutely necessary in some kinds of work, but generally, correctness is far more desirable in the feet and inches, than it is in thousandths and thirty-seconds. There is a consistency of work which may only be explained by the homely old proverb, "There is no use in planing the under side of a barn floor." Many Engineers knowing this, have yet an indecision on such matters, that renders them very expensive assistants.

The greater part of all field work consists in making measurements, either linear, or angular, and this of course implies objects between which the measurements are made. Such objects may be already existing on natural, or they may be put in for the purpose of measurement, or of the definition of a measurement made at the time. Such objects are permanent or temporary. We shall describe a few of them and here in the remainder of these articles, we shall try to describe the most accurate and best means first, as "slip shod" habits and methods are very easily deduced from them.

POINTS OR STATIONS FOR MEASUREMENT.

Natural or existing objects are used when they are suitable for accurate measurement which is not very often the case. The corners of buiklings and of fences, trees, corners of masonry in place and the banks of streams are often used as the boundaries of measurements, but they are not very satisfactory unless well defined and permanent. Corners of ashlar masonry or of brick-work are tolerably definite, but trees are very far from being so. As such objects seldom happen to be in the places wanted, and are generally too indefinite for accurate work, it becomes necessary to put in points for the use of the survey as the work is proceeded with.

For really permanent points the best method is to place a stone block, say 12 inches square and 6 feet long, on end, in an excavation about 7′ 6″ deep, and then ram the earth well in at the sides of the stone. A copper bolt 1 inch in diameter and 10 or 12 inches long is then let into the end of the stone, driven in if the stone be sound enough, otherwise, secured with lead. On the head of this bolt, a cross may be easily made with a fine pointed tool, or a sharp chisel, and the intersection of these lines accurately determined (It is always better to determine the position of a well defined point, than to try to establish one or make a mark in any given position.) After the point is carefully established or determined, and its immediate use over, a board should be placed over the top of the stone to protect the copper from defacement and the earth filled up the 18 inches left for that purpose over the stone. A mound may then be made or some other monument erected or the distances to natural objects noted, so that the place may be found again without great loss of time in searching for it. A point established in this way may be considered as permanent, and, if the stone be durable should, outlast the pyramids. Such work is suitable for surveys of states and counties and is hardly required for work of less magnitude.

For some work iron pipes have been buried vertically having a cap or cover on the end on which the marks have been made; a 3 or 4 inch water pipe 6 feet long is cheaper and handier than the stone. It should be rammed inside and out before putting the cap on.

A copper bolt, let into solid rock or solid masonry is considered permanent, but the masonry must have been for some time erected or the settlement fairly made, before absolute permanence can be considered as established.

For less valuable work in cities, and city work comes next in importance, the best place for establishing points is, with regard to permanence, the stone plinths or base courses of the ashlar masonry of buildings; but such places are usually inconvenient in location and not often accessible. Standards of measurement are sometimes made on such places (their use and manner of setting out will be given hereafter.) The most common method in cities is to use the curbstones, and in eastern cities where granite curbs 8″ to 12″ top and 24″ to 30″ depth are not uncommon the curb may be considered as fairly permanent after it has stood one winter, but the disturbing action of frost and water must not be forgotten; in the western cities with a 3″ or 4″ limestone curb, just set into the ground and liable to be moved by every team that strikes against it, the virtues of durability and permanence are both lacking.

Points on the curbstones are usually established by making a cut on the upper surface of the stone with a fine cold chisel; the form is usually a cross, or a "crow foot" (often contracted and spelt "crofut,") so called from the resemblance to the foot of a bird.

Such marks are made where needed by the assistants who should all learn the use of a cold chisel as soon as possible.

In making such cuts with a cold chisel a little practical common sense must be used, and the following are the operations:

First the surface of the stone is to be cleared of the dirt and dust which is on it, and a pencil mark made where the cut is to be—this should be at right angles to the measurement as nearly as possible. If now the chisel be used, the first few strokes will obliterate the pencil line, and the cut may work off to either side of the desired position and this precaution must be used. At the distance of one or two inches from the pencil line which marks the place, a parallel line should be drawn, and the distance between them measured; the cut can then be freely made, and the distance tried from time to time as the operation progresses and the chisel worked over the correct place. This mark is in granite about one eight of an inch deep and wide and from one to two inches long. In softer stone it is a little more in size, but it must not be made too large or its value as a defining mark will be diminished.

After this has been cut the one at right angles to it, or the two side marks of the "crofut" can be made, care being taken that the intersections do not split off. The above description may seem superfluous to those who know all about it, but we suspect that most men spoiled the first mark they every made on a curb stone—we did and freely acknowledge it.

Where the curb stones are close together we always preferred to establish points by driving nails in the joints; in using them, of course, one has to take the distances where they come, and not attempt to set off a given amount. The size of the nail used must of course depend on the opening of the joint, and it should drive hard but not break off. For very accurate work a line may be cut with a cold chisel on the head of the nail, but care must be taken not to cut the head, or a part of it, off. The best measurements we ever made were on points so placed.

In giving lines from such points they are used as reference points of course. This method we prefer when the curbs are solid and close jointed enough for the purpose as they are less liable to be injured by handling of heavy bodies over them, or worn out, and the centre is better defined than the chisel cut in soft stone.

By far the most common means of defining points is the use of wooden stakes which are of various sizes and lengths, the points being marked on the head of the stake by driving a nail, by marking a little hole with the point of the transit rod or by making a pencil cross. For ordinary use, a guess at the centre of the stake is considered as sufficiently close. The size of the stake depends on the stability desired which partly depends on the material it is driven in. We have used in filled gravel for stakes to last six months, a very large size vis., sawed pieces 4″×6″ ×3′ 0″ to 4′ 6″ long using a 20 lb. iron maul to drive them with. The points should be sharpened on both faces equally, or the stake will not drive straight. Making stakes is in itself quite an art and is one which must be learned young to attain excellence in. Good stakes are the one thing by which good work is distinguished. "By their stakes ye shall know them" might be written as a motto for young engineers.

Good stakes, however, are not all in all; they must be driven exactly in the desired places and they must possess some value after being driven. Stake driving is almost as great an art as stake making, (we did attain to it ourselves with the 20 lb. maul atoresaid, but we never did make first-class stakes yet,) and to get the stake into hard ground, so as to stand plumb and be down solid, and yet have the upper edges intact, is not and easy matter. For frozen ground we have used a steel point, driving it in with spiking mauls, to make way for the stake, and we have used a steel rod 1¼ inches diameter and 6 feet long with a chisel point for the same purpose, using it also as a transit rod. For transit work a strong stout stake is often used, driven flush with the ground and a nail driven therein. A marker must be lett by such stakes in order to find them even an hour afterwards. The marker is sometimes a stake driven about 15 inches from the other one, but longer and left sticking up 15 to 20 inches, or a ring of stones may be made around the stake in question, or piled over it. For earthwork or stone work a stake is usually employed without any closer definition than the guess at the centre. Such stakes of course are very liable to be disturbed by the workmen, and care should be taken that they can be easily replaced without great waste of time. We do remember particularly requesting one foreman to be sure and keep his stakes all right, as we did not want to have to replace them in a hurry, and also remember our feelings when the next day he showed us a little wood pile where he said the men wouldn't take them for firewood as he had saved them for us. That never happened to us but once though.

For land bounds a stone block 6″×6″ and 4′ long is often used with the cross cut on the top, or with one corner on the point and two sides near two of the lines. This latter practice is a little confusing, and differs in various places as to the position of the stone, some placing it on the land defined and some off. The points used by the surveys of the United States Public Land are perculiar and are given in their manuals of instruction—we have had no experience with them ourselves.

S.

The Jetty Experiment.

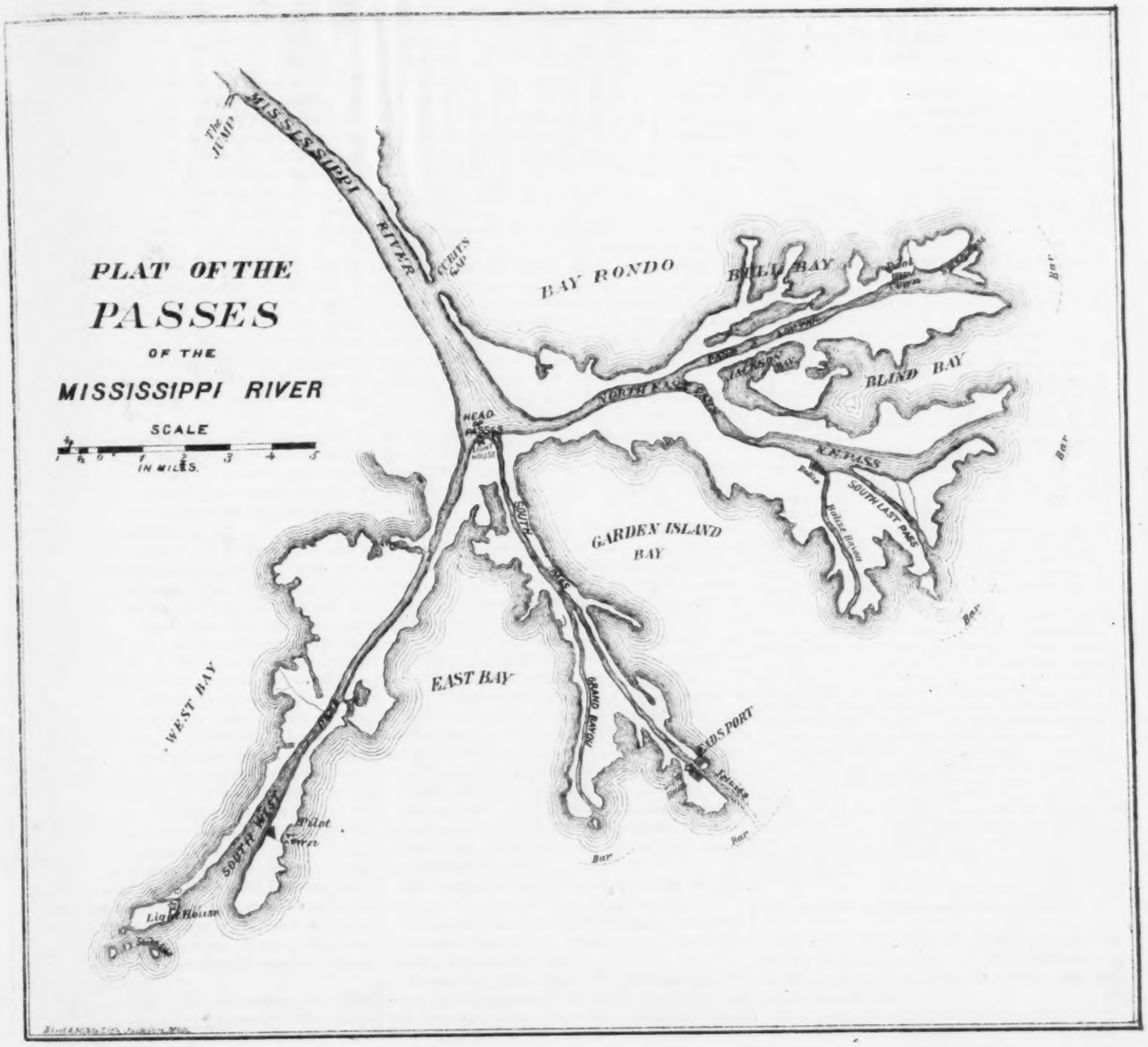
BY J. A. HAYWARD, C. E.

[Written for Engineering News.]

By an act of Congress approved March 3d, 1875, Jas. B. Eads was authorized to build and maintain jetties in South Pass, Mississippi River, for the purpose of forming a navigable outlet from the Mississippi to the Gulf. Mr. Eads was to build these jetties as an experiment at his own cost, and to receive his pay in proportion to the depth of water secured, referred to the plane of *Mean High Tide*; the first payment to be made when a channel twenty feet deep and two hundred feet wide had been secured.

Being undertaken as an experiment involving large private capital to be returned only when the jetties proved successful, the enterprise has been watched with deep interest, not only by those who had risked their capital in its succes, but also by those who, in a position to study the peculiar features of the problem, had, long before, pronounced any system of jetties at the mouth of the Mississippi River, as an ultimate, positive failure.

Various methods have been tried to make and maintain a deep channel over the bar at different passes of the Mississippi River. The most successful of these has been the system of dredging, now, and for some years past, in use at South West Pass. By this system the deposit forming the bar is thrown up to the surface of the river, and by the current carried out to deep water before being again deposited. The two dredge boats have maintained at South West Pass a channel from eighteen to twenty feet deep—mean hige tide—and from seventy feet to one hundred feet wide for that depth, through both the high water and low water seasons. But all efforts to secure a deeper or a wider channel at any


PLAT OF THE
PASSES
OF THE
MISSISSIPPI RIVER
SCALE
IN MILES.
MISSISSIPPI RIVER
BAY RONDO
BULLY BAY
BLIND BAY
NORTH PASS
HEAD OF PASSES
SOUTH PASS
S.E. PASS
SOUTH EAST PASS
GARDEN ISLAND BAY
EAST BAY
WEST BAY
GRAND BAYOU
BALIZE
Bar

pass of the Mississippi for any length of time, has so far signally failed; from which it would appear that at this depth and width of channel, a condition of equilibrium exists at the crest of the bar between the maximum power of the current to retain sediment until it is deposited in deeper water beyond the bar, and the tendency of the sediment to settle at the slackening of the current.

The dredging always secured the deepest and best channel at South West Pass. The per cent. of water flowing through each pass at the time Mr. Eads commenced his work on the jetties, and now, is as follows:

	S. W. Pass.	N. E. Pass.	South Pass.
March, 1875.	0.42	0.43	0.15
June, 1876.	0.45	0.43	0.12

In 1873 Congress passed an act giving to the U. S Engineers control of that pass where the dredging was going on. They were then working at Pass a Loutre. That pass had, at the time the dredge boats commenced working there, but 12 feet of water over the bar at high tide. In two weeks time this depth was increased to seventeen feet. Before low water the channel had been deepened to nineteen feet, mean high tide, and seventy feet width for that depth; and this was the best that could be done by dredging.

The accompanying plat of the passes was taken from the U. S. Coast Survey Chart of 1873. From it will be seen that the distance of the bar of the three principal passes from the head of the passes is as follows: South West Pass, sixteen miles; Pass a Loutre, fourteen miles; South Pass, eleven miles. The fall being the same in each case, of course gives the most rapid current to South Pass making it, for that reason, most suitable for jetties.

It was while the dredge boats were working at Pass a Loutre that the writer was stationed for several months at the passes, to assist in surveys, current measurements, and other observations constantly being made there. I had, therefore, a rare opportunity to study the phenomena of that very interesting region.

The most interesting result of the work at Pass a Loutre was a constant deepening of the entire outlet from the head of the passes to the bar itself, so long as the channel over the bar was kept open, and a corresponding shoaling of South West Pass, both in the pass proper and on the bar; and when the dredge boats afterwards returned to South West Pass the old condition of things was resumed, the bar and pass at Pass a Loutre shoaling while that of South West Pass deepened.

I will treat at length of the various causes that lead to the bar formations, in a future article. I will merely say here that it is partially caused by the rapid deposit of sediment held in suspension by the waters of the Mississippi. This rapid deposit of the sediment is caused by the slackening of the current of the river as it strikes the salt water of the Gulf. Anything that slackens the current will cause a deposit of sediment there. This is true of the whole river. If a boat happens to get aground, either in the river or on the bar at its mouth, the water will immediately commence to shoal below and around it, until sometimes it comes to within a few inches of the surface of the river. Anything that accelerates the current causes an immediate temporary deepening at that place.

In harmony with this last statement it may be asked; "Why then will not the jetties succeed?" The answer is easy enough. In order to insure the necessary velocity of the current at the crest of the bar by a system of jetties, the water must be confined by gradually contracting the channel until by this partial damming the level of the water is raised sufficiently in the pass above to give the necessary increase of velocity at the exit. By this means the conditions that first caused the formation of the bar instead of being dispensed with are merely forced further out into the Gulf and a new bar formation takes place beyond the old bar, necessitating a constant extension of the jetties. By extending them from year to year, it is claimed by the projectors that the jetties can be made a success, But if success means a permanent depth to excede twenty feet, it is evident that they can only be a failure.

But aside from the constant, inevitable shoaling process going on just outside the mouth of the jetties, another shoaling would take place above and between the jetties, much more fatal in its effects. This would be caused by the slackening of the current in consequence of the partial damming of the water by the jetties. This would be fatal because by no system of jetties or dredging can this shoaling be prevented. This shoaling would extend far into, if not the entire length of the pass; because the water surface being raised at the upper end of the jetties and necessarily not raised at the head of the passes, the current must slacken between the head of the passes and jetties and cause a deposit of sediment between those points.

The jetties are now so far constructed as to secure nearly the entire benefit that can be expected from them, so long as they remain in their place. Let us see, now, to what extent the results verify the theories on which the opponents of the jetty system based their opinions.

Their first effect was to deepen the channel over the crest of the bar until eighteen and one-half feet, mean high tide, was secured This was produced principaliy by a system of dredging, consisting of a huge rake dragged along the bottom by a tug boat, stirring up the mud into the current, thereby forcing it out beyond the jetties to be re-deposited. It appears, however, that eighteen and on-half feet indicates the most favorable condition existing for jetties; for since that time shoaling has persistently taken place until at the mouth of the jetties not more than sixteen feet can be found, and rapid shoaling has taken place both above and below that point. From this it appears that the opponents of the jetty plan have not erred when they claimed that a channel of twenty feet depth could not be maintained over the bar at any pass by the jetty system. A few more results, obtained from perfectly reliable sources, verifying their theories, may be mentioned here.

1st. That according to Gen. Comstock's report of April 30, 1876, the crest of the bar has advanced, since March, 1875, about three hundred and fifty feet out into the Gulf.

2nd. That the water is shoaling rapidly beyond the mouth of the jetties even out to one hundred feet depth in the Gulf.

3d. That according to Gen. Comstock's report, above cited, a shoal is forming in the South Pass just above the jetties, the bottom having raised there from four feet to eight feet since work on the jetties was commenced.

4th. That one mile below the head of the passes the bottom of South Pass has raised eleven feet within the past year, giving a present depth of twenty-eight and one-half feet, where, before the existence of the jetties, we could always find thirty-nine and one-half feet.

5th. That the entire character of the bottom at the head of South Pass has so changed since Mr. Eads commenced his work on the jetties that the old channel has nearly filled up to the surface, and no new channel has as yet been secured, although efforts are being constantly made by Mr Eads to deepen the water there. In fact the combined results of his work has been to reduce the volume of water flowing through South Pass, fully three per cent. of the entire volume of the river, within the past fifteen months.

Thus we see that the results anticipated by the jetty opponents have been so far completely verified.

Two months ago several lines of steamers undertook to use South Pass entirely; but nearly all, if not all have returned to South West Pass.

There is one other thing which, although not mentioned by the opponents of the jetties, has much to do with their final success. It is the appearance of mud-lump formations in the channel. These mud lumps are a phenomena peculiar to the mouth of the Mississippi River, and have appeared in both South West Pass and Pass a Loutre just on the outer crest of the bar and directly in the channel as soon as the dredge boats have secured and kept for a time a deep channel over the bar. In both instances efforts were made to keep these lumps dredged down but without avail, and the channel had finally to be changed at both passes to get by them, A similar formation is appearing just outside the jetties, extending clear across the entire channel, and as the jetties cannot be changed, it is but natural to presume that the mud-lumps will continue to rise as in the two instances above cited, and eventually close up the whole pass.

In conclusion I must refer to the letter recently published from Mr. Eads to the Secretary of War, and the reply, also published. From these letters it appeaas that Mr. Eads demanded and secured the suspension of all soundings and observations in South Pass, except those made by Gen. Comstock. He has also secured an order for Gen. Comstock to report to him, and has tried to prevent his publishing his reports. While this interfered with a series of surveys, for some years past and at present, conducted by the U. S. Engineers and extending over all the passes, it also looks as if Mr. Eads feared to have the true results of his improvements in South Pass and at the Jetties, known. [The letter of the Sec. of War will be found below. Ed.]

Letter from the Secretary of War to Captain Eads.

The following is the letter of the Secretary of War, J. D. Cameron, to Captain Eads, referred to in our editorial columns:

WAR DEPARTMENT, WASHINGTON, D. C., June 28, '76.

Sir.—I have the honor to acknowledge the receipt of your letter of the 20th inst., requesting in substance:

1. That in future the inspecting officer comtemplated in the act approved March 3, 1875, for the improvement of the South Pass of the Mississippi River, be required to make his report directly to the Secretary of War.

2. That the duty of observing and reporting upon the progress of the work, the manner of its construction, the results accomplished by it. and all other matters relating to said improvement. which the Secretary of War may direct, will henceforth be performed by the said inspecting officer exclusively.

3. That any official publications with reference to the said improvement will not be permitted from any other officer of the Engineer Corps.

4. That the Chief of Engineers be directed to discontinue all surveys of the South Pass and its bar, that are not under the direction of the said inspecting officer.

5. That the said inspecting officer be directed to furnish you and your authorized assistants any information he may possess, or hereafter acquire, relating to the progress, effects, permanency, or probable success of the work.

Your first request has been granted, and I beg to inclose you a copy of the letter directing it.

To the second request I have to reply that the duty therein referred to will be performed by the officer assigned to it, and his assistants, exclusively.

As to the third request, it may be stated as a general rule, that reports made by officers of the War Department to the Secretary, are not published without his consent. If any other officer of the Engineer Corps should be called upon for a report, notification thereof will be sent you.

Your fourth request has already been carried into effect, as the Chief of Engineers on the 8th instant, directed Captain C. W. Howell, the officer in charge, to make no soundings, current or other measurements of any kind whatever in the South Pass, or on the bars at its river or sea ends, or in the sea at and off its mouth, but to limit his observations to the other passes and the main stem of the river, should such observations be necessary in the execution of duties heretofore assigned him.

You will perceive by the enclosed copy of letter, that Major C. B. Comstock, in accornance with your request, has been directed to furnish you or your assistant the actual results of soundings that have been or hereafter may be made under his direction, in the performance of the duties assigned him in connection with the improvement of the channel between the South Pass of the Mississippi River and the Gulf of Mexico, under the act approved March 3, 1875.

Report of the Mystic Water Board.

The Mystic Water Board have recently submitted their eleventh annual report. The water from Mystic Pond is supplied to Charlestown, Chelsea, Somerville, East Boston, and Everett, Mass.

From the report we glean some items of interest. It will be noticed that these water-works are a profitable piece of property as bonds to the amount of $167,000 have been paid during the year.

All the time the supply has been abundant, and most of the time a great deal more water has run to waste over the dam than has been drawn from the lake for consumption

The cost of maintaining the works for the year was $113,623 77. The total amount collected for water rates was $238,691 53, of which $3,545 47 was for previous years. The number of water-takers now entered for the year 1876 is 17,729.

The rain fall for the year was 48.06 inches.

The yield of the lake for the year was as follows:—

	Gallons.
Total waste on the overfall	8,384,841,081
Waste at fishway	200,000,000
Waste at "waste weir" to the conduit	400,541,570
Water drawn through the conduit	2,750,279 588
Total	11.735,667,239
Loss on lake .4 of a foot	26,599,636
Total yield for the year	11,709,067,603
Average daily yield	32,079,637

The conduit and all the works are in good condition. The engines at the pumping station have been run 9,806.25 hours, and pumped 2,750,279,588 gallons. The cost per day for pumping an average of 7,535,012 gallons was $86 88, and the cost of raising a million gallons to the reservoir, $11 53. Three thousand, two hundred and thirty tons of coal were used at the station. The largest amount pumped in twenty-four hours was 15,543,248 gallons, on the 26th of February, when, for the first time, it was necessary to run all the engines at one time. The whole amount of water drawn from the reservoir during the year was 2,749,556,293 gallons, or a daily average consumption of 7,533,030 gallons, making a daily average for the whole year of 88,157 gallons less than for the previous year. The larest daily consumption was on February 24, which was 15,166,725 and which is the largest since the works were built. The smallest was on May 16, which was 4,892,595 gallons. The water was supplied to East Boston five months, less one day, being let on December 2, and the average daily consumption for this month was 10,087,886 gallons. The relative monthly consumption was as follows:—

	Gallons.		Gallons.
December	312,724,358	June	195,150,457
February	306,249,878	August	189,851,450
January	306,055,308	September	186,726,826
March	289,279,643	October	183,874,900
April	223,614,569	November	179,153,939
July	201,315,424	May	175,559,946

Relative daily average consumption for each month:—

	Gallons.		Gallons.
February	10,560,340	July	6,494,046
December	10,087,886	September	6,224,224
January	9,872,752	August	6,124,247
March	9,331,601	November	5,971,790
April	7,453,802	October	5,931,448
June	6,505,015	May	5,663,228

There have been 896 feet of cement pipe relaid with cement, and 1597 feet of cement pipe relaid with cast-iron pipe. There have been a large number of "breaks" on the cement-pipe originally laid when the works were built, and in every instance the pipe was found to be badly rusted out. The whole number of breaks was 58. The opinion is expressed by some who have had experience with the cement pipe, that it will only last a certain length of time, no matter how well it is laid; that the iron will oxidize under any circumstances, and eventually give out; but with his experience the superintendent is still of the opinion that the whole trouble has been poor work and poor cement. But, in either case, he thinks the plan now adopted, of coating the iron pipe with asphaltum, will obviate the whole difficulty, so that the pipe can be laid to be durable and reliable.

The South Pass Jetties.

The grounding of the steamer *Morgan City* at the head of the South Pass of the Mississippi on the 4th of July was duly announced in the New Orleans papers of the 6th, but has not been telegraphed so widely as was the successful passage of the other ocean steamers not many weeks ago by the same route. The *Morgan City* drew fourteen feet three inches forward, and fifteen feet two inches aft. Major Comstock's third report on the progress of Capt. Ead's work (up to May 1.) in a measure prepares one for such news. An island divides the head of the Pass into two entrances, an east and a west. In June, 1875, a vessel drawing fourteen feet of water could be taken through the east entrance; now, one drawing more than nine feet would ground. This sudden shoaling may have arisen from other causes, but Major Comstock gives good reasons for thinking it due to a jetty three-fifths of a mile long which continues the east bank out into the main stream with a view to increasing the scour of the Pass. The scour of the west entrance, however, he says, is not comparable with the shoaling in the east entrance; and it was in the former, we take it, that the *Morgan City* went aground. Coming to the mouth of the Pass, where there are two parallel jetties, of which the eastern is some 12,000 feet long, the scour again seems to have disappointed the contractor, for he has driven spurs of piling at right angles to the jetties on opposite sides, and has tried artificial stirring up of the bottom with chains and rakes both at the mouth and at the head of the Pass. The bar at the end of the jetties "seems subject to considerable change in short periods. In the soundings of May 3, Capt. Brown found a least depth in channel of 15 feet. On May 10 and 11 I ran," says Major Comstock, "numerous lines of soundings across the bar, but failed to find more than 13½ feet on any line. I was informed that between Captain Brown's soundings and mine a strong southeast wind had blown for several days, which may have caused the shoaling. A few additional soundings on May 28, by Mr. Parmely, indicated that, from scour and raking, the depth on the bar had again increased to 16½ feet." What Major Comstock has to say further, about the advance of the outer face of the bar at the ends of the jetties, and the simultaneous advance of a stretch of deep water just beyond it and of the shoal in which this terminates; and about the instability of the piles and mattrasses as at present constructed and resting on a treacherous bottom, should make our expectations of Captain Eads' ultimate success very moderate, and Congress very cautious in paying for the work alleged to be accomplished.—*Nation.*

Sault River Improvement.

The Nebish rapids, that plague to navigators, situated in the Sault River, about forty miles from Detour, is soon to be remedied. The Canadian Government, by whom the work is being done, has a force of men already on the grounds, with a tug, scows, derricks, etc., and as soon as the quarters for the men are completed the work of moving the rocks in the rapids will be commenced. With a good channel through the Nebish, a canal cut, so as to avoid the long run around Church's landing and the completion of the Sault Canal, navigation to Lake Superior will be made easy, safe, and quick.

At present the canal lock at Sault Ste. Marie is progressing very slowly. But few men are employed at the new lock, but on the improvement to the old canal and the new one 130 men are kept busy. The contractors for the improvement complain that the government is not doing its duty, as it is not, nor has it furnished the stone for the side walls which they are now ready and anxious to commence building. They have their hoist-engine in place, also their derricks, but the stone comes not. The floor is all completed. This is of the most solid kind, being composed of twelve-inch timber laid first lengthwise, then crosswise, and about six inches apart, the spaces between being filled with concrete The water will not be let into the new lock through valves in the gates as in the old one, but from channels underneath the floor. When completed, it will be 535 feet in length, eighty feet in width inside the gate, and sixty feet in width at the gates. The contractors say that if they could get the stone fast enough they have facilities for completing the walls this fall, but they have no hopes of having them done before next fall, on account of the slowness of the government authorities in furnishing the proper material.—*Exchange.*

Manufacturing Notes.

The new wire mill of the Cleveland rolling mill company, Cleveland, Ohio, is completed and the machinery is now being placed in position as fast as possible.

James Goodwin of New York, who for about $25,000 has become possessed of the mills and machinery, which cost $150,000, of the Carroll Paper Company of Mill River, of which he was a stockholder before the failure, is putting the mills in repair, preparatory to starting business again.

The Taunton locomotive works have just completed and forwarded to the Atchison, Topeka and Senta Fe Railroad a first-class eight-wheel locomotive, with 16 by 24-inch cylinders and five-foot drivers. Name, "B. P. Cheney. No. 57." Another for the same road is in process of construction.

The extensive steel works which have been in process of erection by the Vulcan Iron Works Company for some time past, at South St. Louis, were completed July 25, and made their first blow. These works are for the exclusive manufacture of Bessemer steel rails, and are the largest in the country. They cost some $600,000, and have large orders to fill.

The R. Elwood Manufacturing Co. of Sycamore, Ill., is compelled to enlarge its works, to make room for increasing business. The foundry is to be nearly doubled in size, and the basement of the main factory is to be excavated, and converted into a workroom; thus adding one-half to its present capacity. The company will manufacture 3,000 cultivators for next season.

The *American Manufacturer* says that Black, Barneman & Co. have just completed at Lancaster, Pa., an extensive bridge works, which is fitted with the latest and most improved machinery. They are thorough practical mechanics and patentees of one of the best and latest-improved wrought iron bridges, and as they have several contracts on hand already, their prospects are very flattering.

Railway News.

The Chatham branch of the Canadian Inter-Colonial Railway was formally opened on Monday by C. J. Brydges.

The projected Dallas and Palestine railroad is to run from Dallas, Texas, southeast to Palestine, on the International and Great Northern. It will run to the east of the Trinity river, and be about 100 miles long.

A Railroad, forty miles in length, has just been completed from Dallas to Fort Worth. Texas, opening another feeder to the trade of St. Louis. Trains will commence running on Monday next. An excursion party from St. Louis will make a trip to Fort Worth in a few days.

Sandersville *Herald*: The Sandersville & Tennesee Railroad Company broke dirt and commenced building the road last Monday. The road will be pushed rapidly through to completion. The object is to have the road completed in time to ship the incoming cotton crop.

We learn from the *Galveston News* of July 13th, that the force at work on the Trans-Continental R. R., have been pushing things. They have ten miles of track laid beyond Blossom Prairie and seventeen miles westward from Texarkana, leaving a gap of only fifty-four miles to be completed. The track from this end will be likely to reach Clarksville this week.

Colorado, eleven years ago had no railroad; now it has in the north a touch of the Union Pacific; the Kansas Pacific enters it at the middle of the east side, and the Topeka, Atchison and Santa Fe also crosses a part. Many local roads have been built, and the total length of road in the State is now 660 miles. A considerable proportion of this mileage is narrow gauge.

Daylight was let through the San Fernando tunnel on the Southern Pacific R. R. on the 15th inst. This is the longest railroad tunnel in the United States except the Hoosac, and the last completed of 18 on the line of the Southern Pacific railroad between San Francisco and Los Angeles. By the connection of the now separated lines through the big tunnel, there will be continuous railroad from San Francisco nearly to Fort Yuma, a distance of over 600 miles,

The Ohio *State Journal* says: Two corps of engineers are out on the Scioto Valley Railroad—one running a line on the coal branch, and the other on the main line below Chillicothe. The coal branch will probably come in near Circleville—at least that is the intention at this time. The engineers on the line below Chillicothe have reached Portsmouth. The line, as surveyed, runs on the west side of the Scioto River, leaving Waverly about two miles to the east.

It is rumored that the Erie & Chicago line which was formed some months ago, is about to be dissolved. The reason given is that the Baltimore and Ohio, which gives the most of its east bound traffic to Erie, receives but little west bound traffic in return, that company favoring the Michigan Central. The Baltimore & Ohio will on the completion of the New Jersey Southern, have an independent line of its own, on which to run through trains to New York City.

Rapid progress is being made in the building of the Cincinnati Southern road, designed to extend as far south as Chattanooga, Tennessee, where it will connect with a number of leading lines reaching out all through the Gulf States. Very great interest is of course felt in the road by the city of Cincinnati, which up to date, has contributed $16,000,000 toward its construction. By January 1, the road will be open for 160 miles from Cincinnati to a point south of Danville, Kentucky; and it is expected by the Trustees of the road that the entire line, through Kentucky and on to Chattanooga, a distance of 338 miles, will be completed by July 1, 1877.

A Monster Pumping Engine.

We have heretofore given the dimensions of the large engine mentioned below, but as a great deal is just now being published about large engines, we reproduce the figures, which we find in an exchange: The enormous engine at the works of the Lehigh Zinc Company, near Bethlehem, Pa., is known as the "President," and is a vertical condensing engine, 10 feet stroke, with a cylinder of cast iron. 110 inches in diameter. The total weight of the cylinder, with its head and bottom, is 40 tons. The piston rod is fastened to the cross head by a steel nut weighing 1100 pounds. There are two fly-wheels, each 35 feet in diameter, and each weighing 92 tons. The walking beam is in four parts, and weighs in all, 95 tons; it gives motion to four plunger and four lift pumps, raising 17,000 gallons of water per minute from a depth of 220 feet. Sixteen boilers are connected with this engine. The "President" is of 3200 horse-power, and is probably the largest pump in the country, if not in the world.—*American Manufacture.*

Contractors' Intelligence.

The iron bridge of the Toledo, Wabash and Western railroad, over the Wabash at Attica, cost over $100,000.

The Directors have let 6½ miles of the narrow gauge railway, which is to extend from Belmont, Ohio, to Neff's Siding, on the Central Ohio Ry., to be completed by Jan. 1, 1877.

The large dock in process of construction by Contractor Pidgeon, at Newton Creek, Brooklyn, N. Y., adjoining the East side of the Greenpoint Bridge, gave way at an early hour on July 17, and fell into the water, a complete wreck. The dock was being erected for Mr. G. Autenrieth, of Long Island City.

The following were the bids for the Stevens battery, at Hoboken, N. J., on Monday, which cost nearly $1,-800,000; Thomas Rowland & Son, New York, $25,000; E. P. Wiggins, Boston, $35,000; Purvis & Son, Philadelphia, $35,500: and Lesser & Co., New York, $52,-500. The name of the fifth bidder was not ascertained

City Engineer Griffin, of Syracuse, is busy making surveys for a trunk sewer in West Onondaga street; a three-foot sewer through Leavenworth Avenue; a two foot sewer in Plum street, and a thirty inch sewer in University Avenue. All these improvements are sadly needed, and when completed will add considerably to the effectiveness of the drainage of that city.

A. P. Teel & Co. of this city, are engaged in furnishing the slate roofing, etc., for an extensive addition to the works of the Keystone Manufacturing Co., manufacturers of agricultural implements, at Sterling, Ill. The same firm has also, just received the contract for the slate roofing for the new shops of the B. C. R. & N R. R. Co., at Cedar Rapids, Iowa.

The contract for the erection of a new iron bridge, in place of the one which is about tumbling down, over Gunner's Run, at Richmond street, Philadelphia, was awarded to Mr. E. D. Smith, July 17, for the sum of $50,000. Mr. Smith was the builder of the railroad bridge over the river Schuylkill, immediately above the beautiful Girard avenue bridge. The work is to be completed within five months, and it will be begun immediately.

Bids for the extension of the Central branch of the Union Pacific Railroad from Waterville, its present termination to Washington, Kansas, were received on Saturday, July 15, and the contracts awarded on Monday, July 17. The distance between the two points, is 21 miles. There were 42 bidders. The contract for the grading was awarded to J. B. Colt, of Clinton county, Mo. The iron to the Springfield Iron Works, of Springfield, Ill., and for the bridge building and track laying to O. Bishop, of Quincy, Ill. The contract requires that the work shall commence in ten days and must be completed by the 10th of November.

About the 4th of July, the King Iron Bridge Company completed a bridge in Clinton, which the great rain of the night of the Fourth proved to have been too short, an error of judgment on the part of the City Council. The same rain washed away a wooden bridge on Coon Creek, and on Saturday it was decided to remove the new bridge to the latter location, and another bridge twenty feet longer is to be built on Ten-Mile Creek. The contract for the new bridge has been given to the King Bridge Company, of Cleveland, through their agent, J. H. Burnham, of Bloomington, Ill.

Supervising-Architect Potter has accepted the proposals of the following parties for the granite, brick, lime and sand required to complete the new custom-house and post-office in Fall River. Davis Tillson, Rockland, Me., gray granite, $32,668; the Bodwell Granite Company, Rockland, Me., red granite, $51,855; W. H. Hawkins of Fall River, all the brick. sand and lime required to complete the entire building. Work under the contract for iron beams and columns, previously awarded to Bartlett, Robbins & Co. of Baltimore, is progressing. On the gray granite proposals, the highest figures were made by the Fall River Granite Company ($49.961 72), and William and J. Beattie, Jr. of Fall River ($67,428).

Foreign Intelligence.

A Company has been formed in Dublin with a capital of $250,000, which is to provide model dwellings for artisans.

Mr. Bramwell, the well known English engineer, asserted recently, before the society of arts, that railway accidents are frequently aggravated by applying the brake power too sharply.

Some interesting experiments have lately been made in Cork harbor with the Denayrouze submarine lamp. While at the bottom of the harbor a diver lighted the lamp and read aloud from a newspaper an account of an examination of the prow of the Iron Duke, which was distinctly heard at the surface by means of a speaking tube.

A member of Col. Gordon's staff, Mr. Gessi, has circumnavigated the Albert N'Yanza in the little thirty-eight ton steamer "Khedive," brought past the rapids for that purpose at the expense of much time and labor. The Lake is found to be about 140 miles long and 50 miles wide, its banks being covered with dense forests. The southern extremity of the Lake is found to be quite shallow.

The German Government has declined to extend any additional pecuniary assistance to the St. Gothard line, and the enterprise has been reduced to a somewhat precarious plight in consequence. Under these circumstances, the directors of the St. Gothard Company have submitted to the Swiss Federal Council, a proposal for the reconstitution of the undertaking. The gradients of the approaches to the great tunnel will probably be revised, so as to reduce the amount of tunnelling to be executed.

The French Transatlantic steamship company has placed on board the steamship Amerique a new electric light for the purpose of illumination at sea. The apparatus used is a magneto-electric machine, and the propelling power is a small, powerful three-piston engine. The electricity accumulates in large coils or relays, and is conducted by wires through a key or switch board in the captain's cabin to the lamps in various parts of the ship. It is asserted that the light can be plainly seen at a distance of fifteen miles at sea, and that it lights the ship so perfectly that all the details of its equipment and rigging can plainly be descried at a distance of more than a mile. The especial design of these lamps is to furnish light for working the ship, each one being equal to nine hundred carcel burners.

The following are the highest authentic instances of high railway speeds in Great Britian:—Brunel, with the courier class of locomotive, ran 13 miles in ten minutes—equal to 78 miles an hour. Mr. Patrick Sterling, of the Great Northern, took, two years back, 16 carriages 15 miles in twelve minutes—equal to 75 miles an hour. The Great Britian, Lord of the Isles, and Iron Duke, broadgauge engines on the Great Western railway, have each run, with four or five carriages, from Paddington to Didcot in 47½ minutes—equal to 63 miles an hour, or an extreme running speed of 72 miles an hour. The new Midland coupled express engines, running in the usual course, have been timed 68, 70 and 72 miles an hour. The 10 a. m. express on the Great Northern, from Leeds, we have ourselves timed, and found to be running mile after mile at the rate of a mile in 51 seconds, or 69.2 miles an hour. The engines are Mr. Sterling's outside cylinder bogie express engines, the load being ten carriages.—*Exchange.*

Machine Tools at the Philadelphia Exposition.—No. I.

INTRODUCTORY NOTICE.

Before entering upon an extended report of the machines, tools, and labor-saving implements to be exhibited in Philadelphia during the coming summer, it is thought that some preliminary remarks upon what is peculiar in American engineering practice and the causes which have produced what is typical in that practice, will be of use to foreign visitors. In examining an exhibition of this kind, as the experience of many can prove, there is considerable time lost by not being in some degree prepared to judge of what is seen. To make proper estimates and draw true conclusions in such cases, it is necessary to have previously given some study to what may be called the local conditions under which the things which are exhibited have been produced. In this day no other than a comprehensive view, broader than their own country and practice, must be reached by engineers. There is with every one far too great a tendency to estimate the value of whatever is new by how much it differs from their own experience and preconceived opinions, and in the approaching as in former exhibitions the value of the lessons afforded must depend upon how carefully we examine and how well we understand what is exhibited.

To form an opinion of what is novel or peculiar in the engineering practice of America, without at the same time considering the economical conditions which modify that practice, is to lose the greater part of what should be the object of a visit there, and it is with a view to directing attention to this matter that we propose in the present article to say something of local circumstances in America. In the present, much more than with previous exhibitions, will be felt the want of some attention having been given to this matter. In England, France, and Austria, European visitors had the advantage of a tolerably clear understanding of the wants to be supplied by the articles of industry which were exhibited, but in the present case there will be comparatively little of such information. American products which find their way to Europe are either such as have general adaptation or have been modified to suit our markets, but the home demand which determines the character of nearly everything produced in America is, as before said, but imperfectly understood in Europe.

This difficulty must in some degree apply to our own reports, but believing that the Exhibition will be especially fertile in what is interesting and useful to the mechanical engineer, we shall avail ourselves of every attainable means to present a fair and impartial account of the sections which can be classed under the head of engineering machines, tools, and appliances. In our criticisms it would be folly to claim immunity from errors of judgment; it is, however, asked that they be considered candid and impartial. There are perhaps in the case of the present Exhibition fewer economic reasons for holding it, than with any one which has preceded it. There are in fact good arguments to show that in addition to the expense which is sure to fall on the country some disadvantages to manufacturing interests may be expected. Of this matter, so far as America is concerned, we are not at this time disposed to form an opinion, but taking a broader view, there can scarcely be a doubt of the general good which will result from such an enterprise. The large number of American machines and inventions which during twenty years past have found their way to Europe, and especially to this country, is of itself enough to show the interest which will be felt by our engineers and manufacturers in seeing so great a collection of industrial appliances as may be expected at Philadelphia.

This interest, which is in our own country promoted by an extensive trade and our natural relations to the United States, exists as well in many parts of the Continent, because of American precedents being followed in engineering practice. It is futile to expect that our own practice in a country rich, densely populated, and eminently conservative, can pass without modification to the colonies, where circumstances exist in many respects analogous to those in America. It is but natural that when Englishmen leave their own to settle in a new and undeveloped country, the sequences which follow will be much the same when natural conditions are alike, and we venture the opinion that the wants of our colonies in Australia, New Zealand, and Africa, not to mention our dependencies in North America, will be better understood after a visit to the Philadelphia Exposition than

ever before. We are speaking of the machines, tools, and processes of manufacture; but the remark may be equally applicable to various branches of industry which cannot be classed under this head. We have seen in many branches of industry that the Americans, competing with more expensive labour, and with several thousand miles of carriage against them, have forced, as we may call it, their goods into Europe. In some cases this has been enabled by superior natural resources for material, such as wood, but in most cases because of improved labor-saving machines and processes. We will not here point out any such manufactures, as they will again be alluded to in subsequent articles; but we will invite attention to the fact that in supplying our colonies the three to four thousand miles of transit, which acts as a barrier to American products in Europe, will not apply to the markets of the West, and that there must be a constant and careful adaptation of our engineering products to special requirements, or else much of our colonial trade will go to America.

Every year mercantile connexions become weaker, that is, customers are continually becoming more intelligent and critical. The power of centralised capital and prestige avail much it is true, but we scarce need to point out that price and adaptation are becoming greater considerations, and for this reason we cannot afford to neglect the lesson which the Exhibition at Philadelphia may afford. With this much in a general way of the importance of the Philadelphia Exhibition, we will now proceed to point out some of the peculiarities of American engineering practice, and in doing so we must remind our readers of the difficulty in treating this subject in advance. The reasons for this course have already been given, and it is believed will prove correct in subsequent experience. Our remarks, we need hardly say, must apply especially to American practice of the past. The Philadelphia Exhibition will no doubt show a decrease rather than an increase of some of the peculiarities to be pointed out.

Among the characteristics of American machines and tools, a foremost place must be given to a boldness of design and a disregard of precedents. The implements of manufacture employed in Europe nearly always bear some trace of the hand processes which have been supplanted—an attempt to adapt old means to new ends; established modes are abandoned with reluctance and new ones adopted with distrust. In America, on the contrary, there is little or no regard paid to established modes of operating, a plan wholly new is in most cases preferred to an old one, or to an improvement; precedents are regarded with distrust, because progress is marked by change, and change has no risks in America which cause people to dread it; hence the boldness of attempts which sometimes end in success sometimes in failure, in either case the theory is, there has been a gain. This feature of American practice we venture to name as the most prominent; one which gives such scope to inventive talent, and has been mainly the cause of those numerous innovations which follow one upon another so fast, that a continual vigilance is required to keep informed in American engineering progress. This same cause, while its effects for the most part have been beneficial, has nevertheless tended to a distrust of the changes and improvements produced. Upon the whole, however, the good has greatly predominated over the bad; even failures teach useful lessons, and the ultimate effect of American innovations upon European manufactures is much more extended than is generally supposed.

Another characteristic of American practice is a frequent want in machines and tools of the proportions which scientific data furnish. There are exceptions it is true, and many of them, but generally speaking the tools and implements show unmistakable evidence of experimental development. In the framing of machines, strains are often disregarded, and there seems to be an effort to follow deviating and crooked lines when both use and harmony require straight lines. We are not speaking of the ornamental part, which will be noticed hereafter, bnt of expedients such as should be modified by the operative functions of machinery.

In cases where there has been an application of true theory to practice, such application has been characterized by the same boldness and indepedence of precedent which mark general design. If strains or other operative conditions are taken into account there is adaptation which exceeds anything in European practice; proportions are worked out, proved, and applied, which seems astonishing to our engineers, and yet nevertheless are correct. Some examples of the kind, such as brackets for shafts, will be referred to in the main part of our report. The object here is mainly to explain how much farther practical experiments are relied upon in America than in Europe, and consequently how much extra and often useless labor and expense are bestowed upon plans and expedients. The results reached are practical and good; but generally there remains something in each machine to indicate how far tedious experiment has been relied upon. At this time and for several years past, considerable attention has been given in the United States to theoretical training, and while such training can advance only as fast as general education, of which it forms a part, it is easy to foresee a time when constructive engineering in America will have all the aids which now exist in Europe.

A third characteristic of American machines and tools is the economy displayed in their production, and the low price at which they can be sold. This subject and the conditions connected with it would comprehend an economic review of the whole system of manufacture, and is not to be entered upon here further than to mention the types which such a struggle after cheapness produces.

The cheap character of their machinery more than any other feature has led to adverse criticisms and opinions of American practice. In Europe cheap forms of construction are very regularly construed as an evidence of a want of skill; an inference which is to be expected on the part of those who are unacquainted with the different circumstances which control such manufactures in the United States. That a cheap form of construction may indicate a low degree of skill is true, and cheapness is generally one characteristic of unskilled effort; but if in American practice we separate a want of durability and strength into two parts, one the result of ignorance, and the other a sequence of the market, and a result of competition, the first cause will be found a trifling one in comparison. That those who are now engaged in the manufacture of cheap machines and tools can as well make work which will be durable and strong, is by no means contended, but if there was a market for better machines and tools, and the circumstances of the country demanded them, skill required for such better work would not long be wanting; of this there are so many proofs that they scarcely need to be pointed out. We will mention only the manufacture of small-arms and watches, in which the implements employed have attained such exellence that a considerable and increasing demand exists for them in foreign countries.

Ingenuity as an element in American machine tools is or is not a characteristic according to the mode in which this feature is estimated. In a general sense, and applied to the whole practice, ingenious scheming holds a high rank in America; in nearly every expedient will be found some trace of that faculty which is somewhat vaguely defined as ingenuity, but if we are to judge by special examples, we incline to the opinion that several nations in Europe exceed the Americans.

In America everything must be practical; there must be some object fixed in view, and such an object must not be a distant one; hence there is but little chance of any one devoting time and effort to ingenious contrivances as is often done in Europe. Time is too valuable, and the bent of mind does not accord with slow and careful effort; one or two failures will be borne and remedied, but a third will lead to casting the whole matter aside, and taking up some new scheme which promises an earlier result.

The Americans are not ingenious, therefore, except in a general and practical sense; they produce but few things which do not show some ingenuity, and scarcely ever anything of extreme ingenuity. Facts to prove this need scarcely be referred to; nearly every museum in Europe contains examples of patient ingenuity in mechanism, for which there are no parallels in America, and it is, perhaps, best that there never should be; such works, estimated by modern standards, show in most cases nothing but an application of misspent time and effort. They stand as a record of a kind of leisure which can only exist where there is a great inequality of human conditions.

Ornament as a characteristic of engineering practice in America, is one of which it is hard to speak comparatively. It is a peculiarity almost wholly their own, and it is extremely difficult to understand how, among apeople so practical in most things, there is maintained a tolerance of the grotesque ornaments and gaudy colors, which as a rule rather than an exception distinguish American machines. There is something so anomalous in attempting to ornament a machine which is to be covered with grease and dirt and operate where no one cares for or ever notices decoration, that the practice must do much to hide good qualities when they exist.

Perhaps machine ornamentation in America is induced by the effect produced upon the unskilled; if so, it is no compliment to the general intelligence of those who purchase machines. It is, in fact, one of those things for which a reason seems wanting. In England, where machine ornamentation is deprecated, ornamented posters even of railway lines appeal to a kind of credulity which people in the North of Europe cannot understand. There is, as before said, no rational way of accounting for this decoration of machines and tools, and it is to be hoped that the custom will soon be abandoned. Some further notice of the matter will be made in other places, and also of the strict avoidance of everything like decoration by some of the best engineering firms in America.

Lastly we come to speak of workmanship as a characteristic of American practice throughout the country, but in our remarks upon this we must except what is called "locomotive work," which as a rule is as well performed in America as anywhere in the world, both as to the quality of the fitting and the work processes also, some of which are very ingenious and in advance of European practice. In general, however, workmanship in America is a strange mixture of the most accurate and the most imperfect fitting which can be seen anywhere in the world. This diversity of the quality of fitting is such that it is a matter of great difficulty for one not experienced in American affairs to understand how in two works, perhaps within a few minutes' walk of each other, there may be produced work so different as to serve as examples of practice separated by fifty years of progress.

In Europe generally, but in England especially, the tendency is to a uniform standard of fitting, and so far has this been attained that there is but a fraction of the diversity which exists in America. Machine tools for metal and wood, steam engines of certain classes—portable engines, for example—indeed almost any branch of work which can be named, is in England produced, as before said, with considerable uniformity as to the quality of fitting; ten per cent. of variation in price will no doubt represent the extreme difference, while in America this difference, leavimg out the value of material, will in many cases be thirty-three per cent, or one third the whole value of a machine.

The reasons for this diversity will hereafter be farther explained; at present it may be remarked that to construe this difference of quality as a result of more or less skill in those who produce machines and tools would be to make a mistake. A fairer treatment of the matter is to accord considerable ingenuity and skill to those who can so readily adapt their products to the wants of a diversified demand. There is an old saying that "any one can do a good job if time and money are not reckoned," and the truth of this proverb as well as its corollary "that the highest skill is often demanded in the cheapest production," should be continually before an observer in America. There is no intent here to excuse imperfect work, nor to apologize for what is really bad in American practice, but at the same time there is no other point in connection with such practice that demands more caution and careful consideration than what is called their cheap production.

Referring for an example to the American railways, they furnish a good illustration of skill in cheap production. In Europe the abilities of a railway engineer are generally measured by the perfection and permanence of what he constructs. In America the same ability is oftener measured by how much can be produced with a given amount of money. The same rule applies in many respects to the manufacture of machines and tools, and is the legitimate result of economic conditions in the country which a casual visitor cannot well see nor understand.—*Engineering.*

CAPT. EADS' LAST PROPOSITION.

In our issue of July 1, under the head of editorial notes, we made mention of a scheme which Mr. Eads, together with many of the people of St. Louis, had in mind, and would probably broach at no distant day, viz: to improve the Mississippi River so as to give ship navigation to St. Louis. We then stated that the Mississippi was navigable for ocean vessels as far as Memphis, but that considerable improvement would be needed to give the requisite depth from that point to St. Louis.

Much sooner than we expected, Mr. Eads, has, in the past two weeks, appeared before the House Committee on Commerce, to explain his scheme, which, in brief, is as follows: He proposes to secure twenty feet in depth throughout the river, between the before mentioned points, by reducing the river to an approximate uniformity with the present width in the narrower and deeper sections of the channel.

This will produce, when the channel shall be scoured out to a uniform cross-section by confining the water between parallel dykes, a uniform regimen without that injurious variation of current velocity, to which he attributes most of the evil effects of caving banks, etc. It will also, on the whole, reduce the slope of the river or lower the water between the banks.

Between Red River and Vicksburg, he proposes to make two or three cut-offs which will lower the flood-line several feet, and thus do away with the levees which the U. S. Commission recommended, and estimated to cost forty millions of dollars.

Mr. Eads' theories, on which he bases his schéme, may be found in his Review of the Report of the U. S. Levee Commission, dated St. Louis, Feb. 19, 1876.

The scheme itself may be summed up under two heads:

1. To reduce the river to a uniform width and depth, and also, to diminish its surface slope by a system of parallel dykes on the wide reaches.

2. To permanently shorten the river by means of cut-offs. As the surface slope is supposed to be fixed or permanent, this must result in a lowering of the bed above the cut-offs, thus lowering the flood line below the natural banks, and doing away with the necessity for levees entirely.

The first proposition is, we believe, practicable, although the forces which are to be brought into subjection are on a scale so grand as to shake our confidence, somewhat, as to the feasibility of doing it at reasonable expense. If our memory serves, a similar idea has been recommended by an officer of the Engineer Corps, for some of the shallow reaches below Cairo, and will be found in a past report of the War Dept. It has been applied for many years by the State Engineers of New York, and also the Government Engineers, to the Hudson River, and has met with entire success.

Until the river has assumed a permanent regimen, consequent upon the improvement, the dykes will undoubtedly oppose an additional resistance to the current resulting in an increased hight of water surface. But as none of the water dammed back, can escape laterally, as at the head of South Pass, we can rely on the current to ultimately reduce the river to a uniform cross-section.

The second part of the scheme has no necessary connexion with the first, its object being quite distinct from the improvement of navigation, except so far as it may shorten the length of the river.

Cut-offs on the Mississippi are by no means frequent, but several have occurred since its banks have been occupied by habitations, and their history suggests extreme caution as to their employment, if, indeed, in the long run, it does not argue against their utility in any case.

They are found to lower the flood-line above, sometimes several feet, which they do by drawing off the water with greater rapidity, owing to increased slope. In one case the effect of a cut-off was felt for a distance of a hundred miles above. The drawing-off of the water above, of course, raises the flood-line below, by an amount equal to about one half of that by which the flood-line is lowered above.

The ultimate result would be that the cross-section below would probably accommodate itself to the increased duty, and no extra rise be noted, and the river above if the banks could be considered as stable, would lower its bed, under the increased slope, until the former slope was restored, always provided that the bed is of a character to be excavated by the river current.

But as the banks are far from stable, under the increased velocity above, the excavating power of the river is increased, which takes effect chiefly in the concave parts of the bends, wearing them away with great rapidity.

Below the cut-off the increased volume of water tends to produce an increased cross-section; at the same time the water impinging at a different angle on the opposite shore produces a change in the bends which is felt for miles below. In fact the whole river, both above and below the cut-off, for a great distance has its excavating power accelerated until in time, by new bends or detours, the old slope of the river is restored and the regimen again becomes tolerably permanent. The inhabitants of the valley regard the cut-offs, on the whole, as an evil, although they have afforded temporary and local relief in some instances. The river has never been permanently shortened nor has its flood line been permanently lowered by them.

How Mr. Eads proposes to control the river above and below the cut-offs, after they are made, we have not learned; but it would be a work of exceeding difficulty, indeed if possible at all, in water of a hundred feet depth or more, as it not unfrequently is about the bends.

The theories on which Mr. Eads argues the practicability of these schemes are, on the whole, similar to those which he advanced in regard to the South Pass jetties. As the succes of these jetties are by no means assured as yet, we think the improvement of the lower river by any scheme based on similar reasoning, quite premature. In a year, at most, notwithstanding our sources of information are somewhat circumscribed, we shall be able to judge as to their ultimate success.

Then, better than now, we shall have data by which to determine the advisability of allowing Mr. Eads to attack the up-river problem.

CHEAP TRANSPORTATION.

THE *Railway Age* in an editorial headed "Cost of Railroads per Capita," gives some interesting statistics, taken from Poor's Manual. The gross earnings per capita of all the railways in the United States is $11.49, distributed as follows: New England, $12.83; Middle States, $15.69; Southwest, $4.14; Western States, $13.33. An analysis of the aggregate develops the fact that for mails each inhabitant pays $0.87; for passenger carriage, $3.18, and for freight, $7.44. The net earnings of the roads are $4.24 per capita on an investment of $107. We agree with the *Age* that the influence of the railways is far reaching in its extent, affecting indirectly the interests of every inhabitant, and that the cost of the service in view of the above statistics, is moderate and reasonable, and ,on the whole, the railways, at present, are well managed and the country has no reason to complain.

While the railway is undoubtedly the common distributor, for certain trunk lines of traffic, especially that by our northern lakes, the water line has, in the past, been a competitor and done much to lessen the rates on certain articles of shipment, especially that of grain. With the war that has been waging at various intervals between the railway lines for the past three years, this has not been so true, but it is admitted on all sides that this war on rates cannot, ultimately, result in benefit either to the shippers or the railway companies. During the past week while grain freights by rail from Chicago to New York were 12 cts. per bushel, we noticed that by lake to Buffalo, grain was taken at 1½ cts. and to Kingston at 3¾ to 4¾ cts. Rates through the Erie canal were 6½ cts. On the whole the rate to the seaboard by water was about two-thirds that by rail.

Of course the railways have a certain advantage in point of despatch which is often a consideration; but the rates in both cases are abnormal and temporary.

We have not the statistics at hand to compare the past two or three years, but as illustrating the relative importance of railway and lake transportation a reference to the Senate Report of 1874 will not be without value.

For the five years, 1869 to 1873 inclusive, the all-rail rates averaged 33.55 cts. per bushel from Chicago to New York; lake and rail, 25.87 cts.; lake, canal and Hudson River, 20.77 cts. In each case the rate was quite uniform from year to year.

The total shipment of wheat from Chicago in five years was, by rail, 17,268,483 bushels; by water, 61,190,360 bushels. The total shipment of corn in five years was, by rail, 18,804,732 bushels; by water, 140,895,916 bushels. The relative shipments by rail and water varied considerably from year to year, and the rate was fairly constant as a whole, although the percentage of wheat shipped by rail increased slightly in 1873, and that of corn fell off a proportionate amount.

These figures are interesting, and show, for the five years under consideration, that the cost by water was about two-thirds that by rail, and by water and rail about three-fourths that by rail; also, that about 78 per cent. of the wheat and 89 per cent. of the corn or about 85 per cent. of the total amount of wheat and corn shipped from Chicago went by water.

Another interesting fact may also be developed. The average cost of grain shipment for the four winter months, when there was no water competition, was 39.75 cts., and for the six summer months, omitting April and November, 30.1 cts.; *i. e.*, the rates by rail were 32 per cent. greater without water competition than they were with it. Of course the cost of carrying freight is much greater in winter than in summer but we venture to say that the discrepancy would not exist if the water lines were open.

The relative cost of the various methods of transportation is about as follows: On railways, through freight, 8 to 10 mills per ton per mile, the cheaper rate being on the N. Y. Central four tracks; on Erie Canal, 6 mills; on ship canals, boats 700 to 1200 tons, 4 mills; on rivers, 3 mills; on the lakes, 1½ mills. Of course the water lines are all larger than the rail routes which diminishes, somewhat, the relative difference between given points.

In three years time the enlargement of the Welland and St. Lawrence canals will be completed, and boats of 1,000 tons, carrying 50,000 bushels of grain can reach the harbor of Montreal at a cost of 7 to 8 cents per bushel. With the enlargement of the Oswego and Erie Canal as proposed by W. J. McAlpine, estimated at $25,000,000, grain can reach the port of New York at a cost not to exceed 8 to 9 cts. per bu. The distance from Chicago to New York by the N. Y. C. & H. R. Railway and connections is abot 980 miles, and the cost per ton per mile would be about 3 mills computed on the rail route. By the completion of the northern water lines at a cost not to exceed fifty million dollars it is possible to lay down grain in the port of New York,at a profit to the carrier, at one-half the absolute minimum cost of railway transportation. While we pay but $7.44 per capita for freight, it can be done cheaper, and no one will deny but with ultimate benefit to the country. At a future time we hope to present a series of articles fortified with all the available statistics.

A. MANIER, the originator of the Grand Canal du Midi, noticed in No. 28 of ENGINEERING NEWS, has replied to the article reviewing his scheme which appeared in the *Pall Mall Gazette*. He enumerates the sources of revenue to the canal which are in brief, as follows: From the estuaries of the Gironde and Aude he expects to reclaim 200,000 acres, which will yield a revenue of £1,200,000; from water for the irrigation of 5,000,000 acres, a net revenue of £500,000; 2,000,000 horse power from water will be available, of which he estimates the revenue on 600,000 only at £5 per H. P., or a revenue of £3,000,000; the traffic likely to pass through the canal in 1880, is 13,619,637 tons, two thirds of which is bound for Mediterranean ports on which there will be a saving of distance of 800 miles, and a revenue, at a very moderate rate, of £2,750,000; the rate borne by the landlords benefited by this improvement, in freedom from inundations, for which the South of France has become noted of late years, in the nature of an insurance on the property, will yield £250,000. From all sources a total income of £7,700,000 may be expected or a net income of £7,000,000. This is about six times the gross receipts of the Suez Canal for the past year.

A. Manier paints the benefits to result to the whole of Southern France in an agricultural and manufacturing point of view, and also to commerce in roseate hues. He promises to give his estimates of the cost of the scheme shortly, when we shall lay them before our readers.

A CRUISE around Lake Nyassa, Africa, develops the fact that the lake is much larger than its discoverer, Dr. Livingston, supposed. It extends to 9° 20' South latitude, and the cruise around it occupied a month.

JERSEY CITY is having the usual trouble in regard to water supply that falls to the lot of towns, especially those towns in which common councilmen take a prominent interest in lettings. Though the city runs a trap ridge, called Bergen Hill, on one side of which is a salt marsh running out to the Hudson River and New York Bay, and on the other side a similar marsh extending to the Passaic River and Newark Bay; thus the city is cut off from any watershed. In 1852 the city erected works opposite Belleville on the Passaic. In 1871, the supply proving insufficient, the works were enlarged and a reservoir contracted for, on which a million of dollars has been expended without its being yet completed. In the mean time the Government has removed the rocks at Bird's Reef, just below Belleville, and the tide moves the sewage from Newark and Patterson back and forth before the Jersey City works and not infrequently in low water, salt water is pumped. So the new pumping works and the unfinished reservoir is a waste of money so far as a supply of pure water is concerned, and the city is looking about for a new supply. Various schemes have been proposed; one to tap Saddle River or the head waters of the Hackensack; another to purchase the Morris Canal, which owns a large part of the water-shed of New Jersey, and lay the pipes along the bed of the canal, giving a gravity supply of 200 feet head; a third, is to take the water from the Passaic at Little Falls and pump it up into a reservoir which can be made in the adjacent mountain 300 feet above tide water and of 1,500,000,000,000 gallons capacity; a fourth is to raise the dam at Little Falls so as to flood 1,500 acres of swamp lands and take the water by gravity from that; a fifth, to construct pondage reservoirs up in the mountains. A meeting of the water officers of Newark, Elizabeth, Orange, Paterson, Passaic, Hoboken, Jersey City, Bayonne and adjoining towns is called to meet soon to determine upon some plan for a common supply. In the meantime no one has the slightest idea which is best and we presume it will take them as long to decide the question as it has the authorities of this city to decide the City Hall muddle, which, by the way, is not yet settled.

A NEW fountain nozzle of very ingenious and novel construction has been devised by M. Turettini of Lyons, France, which promises to be of great value to cities which have water supplies of considerable head. It has been tried in Lyons and also Geneva, Switzerland, and has met with complete success. It is on the principle of the Gifford injector, the narrow nozzle through which the water issues with great velocity, being surrounded by a "petticoat" which bulges just above the interior nozzle and is then drawn out into a larger nozzle; the lower part of the "petticoat" dipping beneath the surface of the water in the basin. The water is drawn from the basin and carried up with the stream from the interior nozzle, thus augmenting the volume discharged, but of course to a less height. As small jets under great heads break up at no great hight, this diminution in hight of jet is less than would at first be supposed. An additional petticoat may be provided connected with the air by a pipe, the air drawn in converting the jet into a mass of spray. The economy of this jet is said to be 40 to 50 per cent., but of course this will vary much with head, the result to be attained, etc.

FROM time to time the idea of making Paris, France, a seaport is agitated. The river at Paris is between 60 and 70 feet above the sea, and the distance in a straight line but 120 miles, although by the course of the stream it is 210 miles. To straighten the river somewhat and dredge it out to seven feet would cost 13,000,000 francs, and to ten feet about 24,000,000 francs. This of course would be available for ships of moderate tonnage only.

PROPOSED WATER ROUTE BETWEEN CHICACO AND THE MISSISSIPPI RIVER AT ROCK ISLAND.

Of the several projects proposed for the purpose of connecting the Mississippi River with the Atlantic Ocean by a continuous line of water navigation, the scheme for connecting the lower end of Lake Michigan with the Mississippi river at Rock Island, Ill., possesses many features that are worthy of careful consideration.

Two-thirds of the entire distance is already an improved water route, requiring merely the enlargement necessary to make it fill the requirements of larger and deeper draught vessels. The surveys for this have already been made, under the direction of Col. J. N. Macomb, U. S. A., by F. Doran, C. E., from whose report the following data are chiefly taken.

Following the Ill. & Mich. canal from Chicago to Joliet, a distance of 32.65 miles; it is proposed to increase its prism to 160 feet width at water line, and seven feet depth with slopes of 1¾ to 1, giving a water area of 1,168 sq. feet. The slope or fall contemplated is 0.28 ft. per mile; the size of the lock chamber, 350 feet between mitre sills and 75 feet in width.

The first 29.55 miles is summit level, the first 15 miles of which is through a formation of blue clay with an average cutting of 16 feet, the balance being through magnesian limestone. The total number of cubic yards of earth excavation for this distance is estimated at 10,921,464, and of rock, 3,915,950. Three locks will be required between Chicago and Joliet, with a total lift of 34.7 feet.

The total estimated cost for this 32.65 miles is $11,532,632.40.

This section is happy in its geological features, passing as it does through a limestone formation, possessing the necessary attributes of good building stone, and thus rendering high prices and long transportation of building material for locks, etc., unnecessary.

From Joliet to La Salle, a distance of 66.63 miles, the estimates are based on a slack-water navigation except a short line canal around the rapids at Marseilles.

The river, in this distance, averages about 600 ft. in width, with banks from 15 to 25 ft. in height. The fall and the velocity of the current vary materially on different sections. At Marseilles Rapids the fall is 9.36 ft. per mile, being the maximum. The minimum fall occurs at Joliet Lake, being only .002 ft. per mile. The discharge of water measured at a point 9 miles below Joliet was found to be 523 cu. ft. per second, and at La Salle, 933 cu. ft.

The total fall between Joliet and La Salle is 103 ft., to be overcome by 11 locks and dams, and for two of these, it is proposed to use dams already constructed by private parties. Owing to the high banks the damage to property lying adjacent to the river will be very small. The total estimated cost of this division, is $4,347,879.80.

From La Salle to Rock Island the proposed route follows the Illinois River, already improved, to the neighborhood of Hennepin, a distance of 19 miles; thence turning west it reaches its summit level in the vicinity of Sheffield, a farther distance of 25.86 miles, following substantially the line of the Chicago, Rock Island & Pacific Railway.

To overcome the rise in this distance 19 locks will be required, having a total lift of 207 ft. The summit level is to be supplied by a feeder 38.12 miles in length, tapping the Rock River at Dixon. Westward from the summit the line follows the valleys of the Green and Rock rivers to the vicinity of Rock Island, a distance of 39.45 miles, with a total descent of 92 feet, divided into 9 locks.

The total cost of this division, including feeder, is estimated at $12,479,693.27, making a grand total for the whole length of water way from the Mississippi to Lake Michigan of 183.59 miles, at a total estimated cost of $28,360,505.47.

In our opinion it is doubtful if the surveys from Hennepin to Rock Island have been of a character such as to make the estimates based on them thoroughly reliable. This is particularly true of the western end of the proposed route. There is, however, no doubt, from the general character of the country through which the line passes, that the canal could be constructed at present, for less than the estimate of 1874.

We think there must be some mistake in regard to the excessive fall, 0.28 ft. per mile, which it is proposed to give to the long level at the Chicago end of the route, for such a fall must, undoubtedly, from the current generated, produce great injury to the banks and be also injurious to the easy navigation of that portion of the route.

From Peru to Hennepin, as previously stated, the river is already improved under the direction of the State Engineer, Mr. D. C. Jenne. This portion of the route, from Chicago to Hennepin is also a part of the proposed improvement in connexion with the Illinois River improvement, now in progress, and will undoubtedly be made at no distant day. So the section from Hennepin to Rock Island only, can be considered as in the nature of an undecided project. This section, as previously stated, will be 65.31 miles in length with a total lockage of 299 ft., 207 ascending and 92 descending, and is estimated to cost with feeder, $12,479,693.27, which is probably excessive.

The locks contemplated will admit a steamer and a tow of barges capable of carrying 2000 tons of freight or 66,666 bushels of wheat. The supply of water will be sufficient for 67 passages eastward per day, giving a daily capacity of 134,000 tons of freight or 4,466,666 bushels of wheat, or 1,071,999,840 bushels for a season of 240 days,—about ten times the greatest amount ever received in Chicago in one year. The time required for the passage will be from thirty-six to forty-eight hours. The cost per bushel from Rock Island to Chicago, at a libersl estimate, will be from 2½ to 3 cents, or about half the cost by rail at a cent per ton per mile. The cost to other points on the Misssissippi between Quincy and La Crosse will bear nearly the same ratio to rail rates.

The improvement of the Illinois river from Peru to its mouth, now about one-third completed, will cost only $2,500,00. With the Illinois river, the Illinois and Michigan canal and the Hennepin and Rock Island canal stretching out their two arms to the Mississippi, at Rock Island and at Grafton, carrying boats of 2000 tons, Chicago's water lines westward and southward will be complete. Then will it be possible to pour into Chicago, by these lines alone, an amount of freight equivalent to 10,000,000 bushels of wheat per day, or 2,400,000,000 per year, at a saving of at least half the rate by other methods of transportation. The saving on one-third of this, in freight charges alone, would nearly pay for the entire work in one year. Is $30,000,000, for which it can all be done, or $12,000,000, for which the Rock Island division can be constructed, too much to pay for it?

S. L. D.

Elevations of Certain Datum Points on the Great Lakes and Rivers.

The following elevations which are of general interest, are taken from a report by James T. Gardner, Geographer, Department of the Interior, for the year 1873, and recently appointed chief of the topographical survey of the State of New York. This work was undertaken for the purpose of determining the elevation of Denver, Colorado, which is at present the base from which all altitudes in the Territory are measured. The following elevations are adopted by Mr. Gardner as correct.

	Elevation in feet above mean surface of the Atlantic ocean.
Albany, mean-tide in the Hudson river	4.84
Buffalo, bottom of Erie canal	564.26
Buffalo, theoretical surface of Erie canal	573.26
Buffalo, mean-surface of Lake Erie	573.08
Oswego, mean-surface of Lake Ontario	250.00
Three Rivers (Canada), mean-tide	15.00
Montreal, summer level in river	30.00
Port Sarnia (Canada West), mean-surface Lake Huron	589.15
Chicago, mean-surface of Lake Michigan	589.15
Detroit, mean-surface of river	577.05
Lake Champlain, mean-surface at Whitehall	100.84
Quebec, mean high-tide in St. Lawrence river	15.37

The Boston & Poughkeepsie Railway forms the most important link in the line of railways leading from Boston to the Poughkeepsie bridge, now an assured fact. Either in connection with the Boston & Albany or Massachusetts Central at Westfield, and the Poughkeepsie, Hartford & Boston near Boston Corners, it forms a line but two hundred miles from Boston to Poughkeepsie, which is about twenty-one miles shorter than any existing route, and makes the shortest through line from the coal fields to the Connecticut valley, connecting at Westfield with lines which will distribute the freight all over Massachusetts to within a short distance of the seaboard cheaper than any other line. It will run through Massachusetts territory one hundred and sixty miles. H. F. Keith, the engineer, has already commenced making the surveys. No unexpected obstacles have yet been encountered to prevent the new line being the shortest from Boston to Poughkeepsie bridge by many miles.

NOTES.

Mankato, Minn., is talking of water works.

The old railway bridges of the Hoosac tunnel line will soon be taken down and sold.

Boston supports wholly 29 bridges, the parts of 14 within its limits, and pays a part of the cost of three.

At the town meeting in Danvers, Mass., on the 28th ult, the sum of $150,000 was voted for the construction of water works.

At Collingwood on Georgia Bay, Ontario, the water has risen to such a height as to submerge the railroad track and some of the lower streets of the town.

A committee from the Common Council at Janesville, Wis., visited Rockford, Ill., on Wednesday to inspect the Holly Water Works of that place.

The Water Works at Cedar Rapids, Iowa, were tested on the 26th ult. and were found entirely satisfactory, the requirements being more than exceeded. The works are on the direct pressure system.

At the Sault Ste. Marie Canal the toll for vessels locking through, whether sail or steam, is 3c per ton on the tonnage of the vessel, and at the Lake Superior ship canal, 2c on the tonnage of the vessel. At the latter canal there are no locks, thus the difference in price.

During the first six months of the present year 38,757,800 bushels of coal were shipped on Monongahela slackwater, being an increase over the same period last year of 10,492,900 bushels. The coke shipments during the same time aggregated 3,140,800 bushels, an increase of 1,633,900 bushels over last year.

Gen. Comstock, chief of the lake survey, issued orders from Detroit on Aug. 2d for the resumption of work on the lake survey, which was suspended July 1st, for want of appopriations; and three shore parties, five triangulation parties, two leading parties, two astronomical parties, and one magnetic party, will take the field at once.

The singular effect of the low rates prevailing for the carriage of merchandise is, that the Baxter steam canal boats are not running this summer—the proprietors maintaining that they cannot pay expenses. It was claimed when they were first used that steam power was much cheaper than animal. It can hardly be that the owners of horse boats run them for pleasure, and yet they are running constantly on the Erie canal, notwithstanding the idleness of the Baxter boats.

According to the latest accessible returns, the relative importance of the chief empires of the world in regard to territorial extent is as follows:

	Square kilometers.
Russian empire	21 665 726
British empire	20 595 082
Chinese empire	10 266 600
Brazilian empire	8 515 848
United States (without Alaska)	7 828 300

The majority of pumping engines hitherto employed in Holland for elevating water, have been furnished by English builders who have practically had a monopoly in this respect of the Dutch market. They now find formidable rivals in American manufacturers. "The Fitchburg (Mass.) Steam Engine Company," says the *Moniteur Industrial Belge*, "delivered its first machine in Holland six months ago, and has recently delivered its eighth engine in Amsterdam."

We learn from the *Inter Ocean* that Collector Jones of Chicago, has received notice from the West Point foundry, Cold Springs, N. Y., that the two mortars to be used at the Chicago and Grosse Point life-saving stations are finished, and will be shipped in a day or two The mortars are accompanied by twelve balls each, which will be employed in carrying lines to vessels in distress. These life-lines can be thrown with sufficient force to reach vessels at a distance of three miles. The mortars are after the same pattern as those used on the sea-coast life-stations. The station at Grosse Point is a full one, while that at Chicago is a life boat station.

The Spring Valley Water Company, which furnishes the water supply for the city of San Francisco, is about utilizing a recent purchase of water rights in the Calaveras valley, Cal., and in so doing is about to engage in a work of the greatest magnitude. The water-shed which is to be used is situated some ten miles above Sudol, on the Central Pacific Railroad, and is about thirty miles distant from San Francisco in a straight line. Being separated, however, from the city by the San Francisco bay, a much longer distance is necessary to be covered in bringing the water from the mountains into the reservoir. At the mouth of the Calaveras valley is a narrow and high gorge, and through this the Calaveras creek runs. In this gorge a dam 150 feet high, 700 feet long, a quarter of a mile in width at its base and 100 feet at its apex, will be built in order to back the water up and make a reservoir of the gorge itself. From the lake thus created a tunnel, some three miles long, will be built. It is to be of brick and cement, will have an arch of seven feet in the clear, and will carry about 200,000,000 gallons of water a day. At its outlet will be a large filter, and from this a four-foot pipe line will run past Milpitas, Alviso and Menlo Park, for a distance of twenty-two miles, and will discharge into a brick canal ten feet wide and four feet deep; this latter will conduct the water thirty miles farther, to the San Andreas and Crystal springs reservoirs, whence it will be distributed through the city. The total cost of this immense work is placed at about $6,000,000, and it is expected that it will be entirely completed by the fall of 1881.

Manufacturing Notes.

The manufacture of the de la Bastie or toughened glass, has commenced at Hamilton, Ont.

The Detroit (Mich.) Car Wheel company use 40 tons of metal, and turn out 75 car and locomotive wheels per day. They employ 350 hands, and have a monthly pay roll of $45,000.

An English company, with a capital of $2,500,000; have purchased largely of iron ore lands around Chattanooga, Tenn., and will soon commence iron manufacture on an extensive scale.

The Bethlehem Iron Company, of Bethlehem, Pa., now owns and has running six blast furnaces, five of which, with a capacity of 60,000 tons per annum, are running on ordinary pig, and one, of 30,000 tons capacity, on spiegeleisen; an iron rolling-mill, with a capacity of 20,000 tons of rails per year, and a Bessemer steel mill, turning out 50,000 tons of rails. The company employs about 2,000 men, has a capital of $2,000,000, and a bonded debt of $1,000,000. For the last working year there was a loss on the iron work, but it was more than made up by the profit on the steel mill.

New Publications.

The Nursery, for August, John L. Shorey, 38 Bromfield St., Boston, Mass. $1.60 per year.

Annual Reports of the City Officers of the City of Paterson, N. J., for the year ending March 20, 1876.

A New Treatise on Steam Engineering, Physical Properties of Permanent Gases, and of Different Kinds of Vapor. By John W. Nystrom, C. E., Philadelphia, J. B. Lippincott & Co., 1876.

The reputation which the author of the above treatise has acquired in the domain of original scientific research is a guarantee of what may be expected from him on a subject to which he has given his particular attention. In several popular treatises on engineering subjects Mr. Nystrom has struck out new paths for himself in notation, formulæ, and methods of expression, and has endeavored to adapt his teachings to the language of the shop and the level of the average mechanic. In this, his latest work, he has followed his usual course, and in a quite moderately sized volume he has collected a great amount of original information on the subject of steam engineering, which, as he states in the preface "has heretofore not been published" but is now presented in the most condensed form compatible with ease of comprehension, and which must render the work equally popular with those others which have proceded from the same author.

Roper's Hand-Book of Modern Steam Fire-Engines, including the Running, Care, and Management of Steam Fire-Engines and Fire-Pumps. With illustrations. By STEPHEN ROPER, Engineer. It is the only book of the kind ever published in this country, as it contains an elaborate description of all Modern Steam Fire-Engines, Boilers, and Fire-Pumps, and is free from formulæ or ultra mathematical expressions. 16mo, tuck, gilt edge, $3.50.

Claxton, Remsen & Haffelfinger, 624, 626 & 628 Market Street, Philadelphia.

In almost every small town there comes a time when its existence is threatened by conflagration, and its citizens are frightened into the purchase of a fire engine. The usual method was to run the town in debt for one or more hand engines according to the size of the place, organize volunteer fire and hose companies, which were occasionally drilled and which in case of need exhibited more or less efficiency according to the quality of the material composing the company, its discipline, and the value of the appliances with which to do its work. At best it was but a poor antagonist to array against so fierce an enemy as the "fire fiend," and the history of the hand engine and its volunteer companies presents a record more notable for drunkeness and street fighting, than the extinguishing of fires and the saving of property.

But the days of the hand fire engine are about numbered, although that of volunteer fire companies may not be. The *Steam Fire-Engine* is now coming to be considered a necessity in every ambitious town or village in the land, and although the principles which govern its actions are identical with those of any other steam engine, yet there are special features that demand special study.

Mr. Roper's treatise is the only one extant that is devoted to the subject of Steam Fire Engines, and its author has gone most fully into all the details of their construction, management, and care, at the same time giving illustrations of most of the varieties of engines now in use. He has also considered the subject of fires, with precautions against them, and how to extinguish them; fire-escapes; fire-proof buildings; firemen; paid, and volunteer fire departments, and useful information for them; fire-alarms; hose and hose couplings; and how to select a steam fire engine; besides all this and more on the general subject, the book is a complete compendium of tables, and information of value to every person who has any thing to do with steam engines of any kind, while it should be as much an adjunct of the steam fire engine itself, as the wrench or oil can.

City Councils and Water Supply.

The following extract from the Boston *Advertiser*, will strike every councilman who has been through the mill, as having on its face the appearance of truth.

Liverpool has a water problem which is fast demoralizing her councilmen and bringing them to a state of limp and languid exhaustion. The proceedings, as reported, are not unprecedented. In fact, the reports read like a repetition of municipal history not too ancient to survive in the memory of the present generation, and not too foreign to be recognized as a counterpart of American annals, Reports are numerous, long-winded and indecisive. One alderman dislodges an avalanche of statistics against another, but instead of being crushed the other lets loose a still larger mountain, and between the two the whole question is effectually buried and clogged up. One insists that the advantages of somewhere should be considered, and the other retorts that they have been considered and will not answer. One thinks that the council is wanting too much water, and don't know where to get it, and the other declares that it is not asking for enough, and hints that he knows where inexhaustible stores may be found. As far as action is concerned it has thus far taken the form of indicating what the council will not do.

At first it seemed as if they were almost unanimous for what we will call "A" lake, but it was found that that had no bottom, and then they were hot for "B." Then a most inconvenient freak of nature was brought to their attention, and no less than the fact that water would not run up hill. As Liverpool was higher than the lake, and they did not want to pump, "B" was abandoned as impracticable. Then a local engineer, in an unlucky moment, suggested that "C" might be tapped, and off went the committee with the enthusiasm of new discoveries, but, sad to say, that forlorn lake proved to be too high, and it was feared if the water were turned into the mains it would burst all the pipes, and perhaps blow the roofs off the houses. And then they went to "D," but that was found to be too far off, and, moreover, had lead mines enough to poison all Her Majesty's lieges. Then they looked under their noses to "E," and found that the sewage drained into it, and that the yield of even this contaminated fluid would be speedily exhausted. In fact, every scheme thus far has been knocked in the head by some fatal objection, and the water committee is now described as presenting a woful spectacle of hapless dejection and uncertainty. The council, however, is manfully wrestling, with clauses about which the people understand nothing, and of course, there is a prospect that some time and somehow water will be found somewhere, and Liverpool will breathe more freely.

Carrying Azimuth on Long Transit Lines.

BY J. A. HAYWARD, C. E.

[Written for Engineering News.]

By the term "carrying azimuth" we mean, keeping the 0° of the limb always on the true north. The limb being graduated from 0° to 360° the reading of Vernier "A" will always give the true direction of the line with respect to the meridian.

In the ordinary method of carrying a transit line where the instrument is graduated from 0° to 180° either way, and the back sight is always 0°, the advancing line being recorded as deflect right or deflect left,—the chances for errors are so large that often but little dependence can be placed upon the returned field notes of an extensive survey. A mistake made in any one angle is carried through to the end of the survey without a convenient or even reliable check; and should an error in direction be discovered it is very difficult to tell where it may have occurred. Again, if the line in the main bears much to the east or west of the starting point, it cannot be corrected for the earth's curvature without a very tedious amount of calculation.

In the following method of carrying azimuth the advantages are so great as to be self evident upon statement.

Commencing a survey by this method it is desirable (although not necessary perhaps) to secure an observation for the true meridian at the starting point. This may be done and the magnetic variation ascertained at the same time in the following manner. Make the 0° of the instrument and needle the same and clamp the lower movement. Then drive a small nail or peg into a stake or other convenient object not more than three hundred feet distant. As observations for true meridian have to be made after dark, care should be taken to have the nail so near the instrument that it can be plainly seen in the dark by placing a light behind it. The angle to this nail is then read and recorded. Some one or more methods may then be used and the angle of true north obtained. The difference between the 0° as set up and the angle as found for true north will be the magnetic variation, and must be either added to, if the variation is west, or subtracted from, if the variation is east, the original readings, in order that these angles may read with respect to the true meridian.

When ready to commence the survey the transit is set up over the point used for meridian observation and a reading the same as the corrected reading to the nail is set off on vernier "A," and the upper movement clamped. The cross hairs are then brought upon the nail by the lower movement and that is clamped. The instrument is then ready for reading angles, the 0° being the direction of true north.

Calling this point Δ 0 let us suppose the angle to Δ 1 reads—Ver. A, 145° 48′ 15″. Ver. B, 325° 48′ 15″. This shows that the line from Δ 0 to Δ 1 runs southeasterly. Proceeding then to Δ 1 in taking the back sight, vernier B becomes vernier A and would be recorded,—Ver. A 325° 48′ 15″. Setting this angle off for vernier A, clamping the upper movement and sighting it to Δ 0, by clamping the lower movement we have the instrument again ready for reading angles, the 0° being true north.

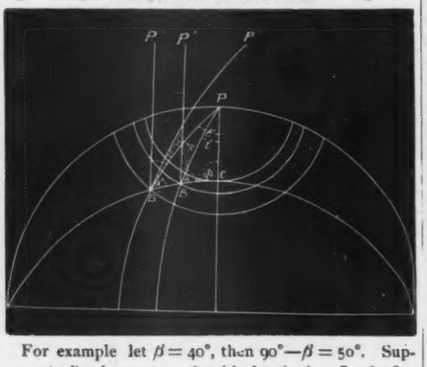
By this method a line may, with care, be run between points varying from ten to twenty miles in longitude with but a few minutes variation of the 0° of the transit from true north.

The principle sources of variation are, 1st. Deviation of the arc of a large circle from that of a small circle. 2nd. Imperfections in the construction of the instrument we are obliged to do our work with. I will deal only with the first cause now, leaving the second for future consideration.

The error in the first case is an unavoidable one and can only be truly remedied by frequent observations for true meridian. In fact these observations should be taken *every clear night*, and it is better to keep the distance between the points of observation within about ten miles of longitude. At each observation the error, if any is found, is applied to the last angle read and the line starts again on true meridian.

In starting from a point on a true east and west line and continuing the same by back and fore sights without corrections, if the earth were a perfect sphere this line would cross the equator at 90° longitude from the starting point. At 180° it would be as far on the opposite side of the equator as the point of commencement. At 270° it would again cross the equator and at 360° it would return to itself again completing the arc of a great circle. A truly east and west line is everywhere perpendicular to the meridian passing through it and is, therefore, the arc of a small circle. This is true for all points between the equator and the poles. At the equator it becomes a great circle, at the poles a point.

In running by back and fore sights, carrying azimuth, if the line runs in an easterly or westerly direction, the 0° of the transit instead of remaining true north will remain on a line parallel to the last established meridian. After running for any given distance of longitude, the amount of deviation between this parallel line and the true meridian may be obtained by the following formula in which (see figure) α = latitude; l = longitude between point of last observation and point under consideration given in angles. A = angle at the second point between the meridian passing through A, and the arc of a great circle passing through and making a right angle with the meridian at the first point of observation. P = pole, then 90° — A = the variation of 0° of transit from the true north. Sub. in formula (82) page. 168. Chauvenet's Trig. we have $tg\ A = \frac{tg\ (90° - \beta)}{\sin\ \alpha}$ subtracting this angle from 90° we have the variation sought.



For example let $\beta = 40°$, then $90° - \beta = 50°$. Suppose the line has traversed 10′ in longitude. In the figure let C be the point of commencement and the 0° of the transit at C be true north. Then at B 10′ in longitude from C, the 0° of the transit will be B P and the angle will be in error P′ B P, or in this case about 0° 08′ 23″. If then the angle is not corrected at B by an observation, but continued 10′ longitude further to B′, the error will be in the above example 0° 16′ 47″. If, however, a correction be applied at B, a new computation must be made in which the latitude of B will enter for the value of β.

Observations for azimuth should be taken as often as possible, and the error, if any be found between points of observation, should be averaged over the whole distance from station to station between them. If no mistake in reading the instrument has occurred this will be practically correct. But much labor in the office can be saved by computing a table from the above formula and applying the corrections from day to day or mile to mile in longitude on the line, always noting the same in the field book when made. If corrections are applied in this manner there should be no correction to be made at the points of observation. An index to corrections and observations should always be kept on either the first or last page of each field book.

This method of conducting a survey is the most accurate and (excepting a compass line) the most expeditious of any I have ever used or seen used. For ordinary triangulation it possesses great advantages, the angles checking themselves on the spot. For intersecting angles to prominent objects along the line of survey, both to locate them and to keep a constant check of the line angles, it is the only feasible method.

The following is the best method of keeping field notes:

STATIONS	VERNIER A	VERNIER B	DIST. BT. STA.	TOTAL.
Δ 0 to Δ 1	165° 30′ 10″	345° 30′ 10″	835	835
Δ 1 to " 0	345° 30′ 10″			
Δ 1 to " 2	260° 38′ 40″	80° 38′ 40″	650	1485
Δ 2 to " 1	80° 38′ 40″			
Δ 2 to " 3	310° 12′ 20″	130° 12′ 20″	143	1628

A field plat of each survey should be made on the ground, in the field book. The right hand page should be ruled in squares. The lines from top to bottom are north and south, across the page, east to west. A small protractor with a convenient scale marked on the edge should always be kept in the field book for making the field plat.

Engineering Field Work.

[Written for Engineering News.]

II.

In our last paper we described the methods of establishing points between which linear measurements are to be made; we will here briefly describe the process of making these measurements.

The operation of measuring always consists in applying some unit of measure to the distance to be measured and counting the number of such applications and parts of an application, and this number expresses the number of units and parts of units in the distance.

The distance betwee two fixed points is the same no matter what units are used to express it in, but the number of such different units in the distance will of course vary inversely as the length of the unit employed.

Accordingly we must remember that a straight line is the shortest distance between two points, and is used to express the distance between them, and also that in most operations of surveying and engineering the horizontal projection of the distance only, is used, and therefore we must make all measurements on straight and level lines. The name of the unit employed depends very much on the scale of operations, and the legal forms which usually have to be complied with, but a more important point by far is the coincidence in length of the nominal unit employed in the work with the real unit implied by its name. Here as elsewhere absolute accuracy is not attainable, and the cost increases with the degree of accuracy attained.

For the most important work, self compensating metal rods in wooden cases are used; such rods are supported on trestles made for the purpose, carefully leveled, and put in line by a transit. In practice three such rods are used, the ends are carefully kept from coming in contact with each other, the distance between marks on the rods is read by a double micrometer microscope; a transit placed at right angles to the line of the measurement is used to do the work usually entrusted to a "plumb line" and the work proceeds by placing one in advance of the other two, lining, leveling, and re-lining it, noting that the two rods placed have not moved, taking the microscope to measure the last interval, and carrying the rear rod ahead and repeating the operations. When it is desired to interrupt the operations, a transit at one side is used to transfer the end distance to some surface below by using the transit in line with the one at right angles to line and this may be done very accurately. The rods may then be left undisturbed with a check upon them by which any movement may be at once detected. Of course such work is expensive, but it has been used with great success in measuring primary base lines by the U. S. Coast Survey.

For less important work rods are used without the compensating arrangements for the temperature. If the rods are brought into contact with each other great care must be taken that they are not disturbed in so doing. Many devices are used to prevent this shock. In some apparatus, a sliding sleeve is put on the end of the rods, and a spring used to take up the shock while the rod is moved by a nut and milled head, till the contact is said to be made when the sleeve has reached a certain position. In other apparatus the rods are kept apart and the distance between the ends measured by placing between them a graduated wedge. Corrections for temperature have also to be made if the rods are of metal; but glass rods of from 12 to 20 feet length and placed in a wooden case have been very successfully used. Hard wooden rods with the ends protected by metal caps, and either brought into contact, or with the distance between points on them taken by a common box-wood drawing scale give very good results. A carpenters' level and "plumb rule" are needed to work with them. Wooden rods need little correction for temperature, and if well seasoned and varnished, are very little affected by moisture. The use of rods of whatever class is distinguished by the rigidity of the unit, and by there being no tension used on the material of the apparatus.

A more common means is the use of a flexible apparatus which can only be got straight by pulling on it. Such are the various tapes and chains in use. Of these

a metal ribbon over 100′ long is the best. Steel and soft brass are used for this purpose, and there are various graduations used. There is in our opinion, and we have had long experience with metals, a very decided preference for the brass tape over the steel tape for the following reasons:

1. The brass tape does not rust as easily as the steel one.

2. It does not break as easily as the steel one—a sharp kink will run close and snap a steel tape which would only make a bend in a brass, easily smoothed out with a light hammer on an ax head or other smooth hard surface, the brass being much tougher than steel.

3. If a break does occur in the brass tape it is easily repaired by soldering a splice on the back, while a good joint in a broken steel tape is by no means an easy one to make.

4. The brass tape can be manufactured at a much cheaper rate than the steel is sold for, the process being as follows: A brass wire is carefully annealed and then rolled out flat into a ribbon say 0.37 by 0.01 inches in cross section. The graduation of this ribbon can be stamped upon it, or marked on it by using in a gold pen, a solution of bichloride of platinum. This deposits black metallic platinum in a very finely divided state on the brass, making a very distinct mark, which may need renewal in a year or so. The cost of such a tape 100 feet long is not over five dollars, and a good box will be made for a dollar or two more. If 1,050′ of wire be made into tapes 105′ each and they be all graduated at once the cost will not be over three dollars each, exclusive of the boxes. The use of the steel tape is very common, the brass one is not nearly so well known.

The use of a metal tape requires many little precautions to do accurate work with it. The distance between the marks at the ends is subject to variations dependant on the changes of temperature and of the tension used in holding it straight. To some these variations may seem of little account, but they are not by any means infinitesimals; 100′ of brass tape changes 0.001′ for every degree Fahrenheit of temperature and so for — 30° F to 120° F as extremes of winter and summer there will be a change of 0.15′ which is nearly 2 inches. But does the summer temperature ever go as high as 120° F we are asked? Not the air, by any means, but the temperature of a metal strip may rise much higher than the air, if exposed to the direct rays of the sun. Any one having doubts about this may try to walk barefooted on the iron of a railway track on a hot sunny day to be fully convinced.

The expansion of a steel tape is almost exactly two thirds of a brass one, and can always be taken so, then for the extreme temperatures given above we have in a 100′ steel tape a change of length of just 0.1′ or about 1¼ inches. As this tape may be used on the same work winter and summer this variation might produce considerable annoyance if not taken into account.

There is another cause of variation in length which is the variation in the pull on the material. On a brass tape of the dimensions given above, this will cause a difference in length of 0.002′ for every pound in the pull, that is to say, a stretch of 0.02′ or nearly ¼ inch will be caused by a pull of 10 lbs. In a steel tape of the same dimensions the stretch will be about ⅓ this amount.

This value is experimental and agrees with the results of computation very closely. The practical way of overcoming these variations is, not to ignore them, which may very easily be done, but to use in conjunction with the tape a fixed standard length, to note the temperature, and finally to pull only a uniform amount on the tape. These precautions will be described in order.

A standard length is prepared by placing two marks as nearly 100′ apart as can be measured, and then carefully obtaining the distance with some known tape or by rods, as described.

This standard should be in some level place, best with copper bolts let in stone, having chisel marks thereon, or if nothing better is found, two nails in some floor large enough to give the distance can be used. Care should be taken to select a place shaded during a greater part of the day, it being difficult to get accurate readings when the tape is exposed to the sun for even a short time. A thermometer must be used to note the temperature and the corrections are made after comparing the tape with the standard. This can be best illustrated by an example. Assume the exact length of the standard to be 100.016′ and that when the comparison is made the reading on the brass tape was 100.023′ and that the temperature was, as nearly as could be ascertained, 56° Fah. Now 100.023 − 100.016 = 0.007 and if the temperature had been 7° more than it was the tape would have given the correct reading, as the nominal 100′ on the tape is in reality 0.007 less than 100′. Therefore, at 56° + 7° = 63° the tape would be correct and 63° is noted as the "standard temperature."

Now suppose the distance between two points is noted as 715.043′ the temperature being 82°. The amount of the correction will be $7\frac{15043}{100000} \times (82-63) = 0.136'$ and as the tape is now long the true distance is greater than the recorded distance by that amount, the real distance being 715.043 + 0.136 = 715.179′. This can all be done mentally with great ease, as no decimals beyond the third place need be carried. For a steel tape two thirds of the difference in temperature from the standard is the number of thousandths to allow for every hundred feet in the measurement, as a correction.

For really accurate work a cloudy day must be taken and especially avoid a day in which cloud and sun alternate; we have had a tape elongate 0.023′ while trying to note the distance, when the sun came from behind a dense cloud. As for the tension, a little spring balance hooked to one end of the tape, and pulled uniformly to eight or ten lbs. while the measurement is being made, easily secures the same pull on the tape at all times. With a tape of this kind the measuring party should be three men, although two can do the work under favorable circumstances. The best work we ever did was in the way just described, when a distance of nearly 1500′ was measured upon level curb stones, the tape being supported across streets at three points at least. Three separate measurements were made on different days under widely different temperatures, and two of the measurements gave the same result, the third differing 0.002 therefrom, the mean of the three being taken.

A note as to the graduation of such tapes with platinum may be useful. Clamp a portion of the tape upon the leveling rod face and square up the face of the tape marking 101′ taking ten at a time, mark the end foot to hundredths of a foot and then mark the 0 a foot from the end, and number from that 100′ which will take all the divisions; in using the holder of the tape box place a mark against one of the points and the other should then come on the graduated foot, the whole number of feet will then be read at the box end and the hundredths at the loose end; thousandths of a foot will have to be estimated between the hundredths. Care should be taken to have the eye of the observer at right angles to the measurement or errors may be caused by "parallax."

Of the varieties of chains used the light steel ones are convenient for city use, but the best for rough country are the heavy iron ones. The "surveyor's chain" of 66 feet is little used by engineers and will soon go out of use it is to be hoped entirely. In using the chain care should be taken that it is not kinked, and that the links are all straight. The number of bent links you can find after a week's work in brush can only be accounted for by "the natural perversity of inanimate things." The importance of holding the chain level, and of carefully plumbing when one end is free from the ground, is scarcely ever realized by beginners, or by some who do not consider themselves beginners, but you can seldom chain too well.

A word of advice to the chainmen will be given in its place later. S.

Report of the City Surveyor of Paterson, N. J.

We make the following extract from the above report:

SEWERS.

In my last annual report to your Honorable Body, I made certain recommendations and suggestions in the matter of inspection, and perfecting the plans of sewers, to which I would again respectfully call your attention.

At first, most of the sewers built under the plans filed in the Department of Streets and Sewers, were built in such manner, and were intended to serve, the double purpose of sewers and drains, a very erroneous application of the sewer plans. Nothing can be more diverse than sewerage and drainage. For the above purpose the invert, or lower half of all pipe sewers were laid dry, the upper section only cemented. The first effect of this plan was beneficial, in that it lowered the line of saturation in the soil, and drained many cellars and low places, that before the laying of the sewers were wet and unhealthy. And as for the first years few connections with the sewers were made, the amount of sewage proper was but a small proportion of the total flow of the sewers, and the healthfulness of the territory thus drained was improved. From time to time however, as the quantity of sewage and effete matter increased, and particularly where the sewers were laid of less size than was called for by the plans, or of less size than was requisite to carry off the sewage and even a moderate rain fall, the reverse effect became apparent, the sewer being filled to its utmost capacity, (a very desirable state were the joints all water tight for its proper cleansing), allowed a part of the flow to pass through the open joints of the invert into the soil, and as the sewage matter, being in most instances heavier than the water, formed a large percentage of such leakage, year by year, the soil has and will become more and more impregnated with matters deleterious to health, poisoning the springs and wells from which many of the people, notwithstanding the much more healthful water supplied by the Water Company, will persist in using. The soil is so impregnated in the hot and dry months, giving off exhalations insidious, and in the direful effect on the human system, fully equal to that arising from the sluggish and filthy brooks and streams which the sewers were intended to supersede, that I doubt not the physician can trace all of these imperfectly and erroneously constructed sewers, by the prevalence of diphtheria, typhoid and other zymotic or malarial diseases.

Sewers thus constructed instead of being beneficial to public health, become as has been remarked by sanitarians but "elongated cesspools," dealing death to the adjacent inhabitants, and even extending to whole cities.

A perfectly devised system of sewerage and drainage is very expensive in execution. It is far better however, that what is done, be it ever so little in each year, should be well done, according to the very best attainable plans and under the most competent supervision. And it is for the purpose of bringing this subject again before your Honorable Board, and to urge upon you the absolute necessity of correcting the plans now on file, amending the imperfect sewers already built, and completing and perfecting the entire system of sewerage for the City at the earliest practicable moment, that I so earnestly refer to the subject.

STREETS.

It appears to me that the proper time has arrived, and that this report is the proper medium, to again call attention to the great necessity that exists, for something to be done in this direction. It would seem a work of superorogation to prove how much the health of the city, as well as its material prosperity would be improved by properly paved and drained streets. For a city such as Paterson almost the entire wealth consisting in its industries, in the iron and coal that require to be transferred through the streets from the Canal and Rail Roads to the mills, shops and factories—one needs but to examine the condition of the streets leading from the source of supply of these heavy but necessary articles, to see at what a disadvantage, in the single expense of cartage alone, our mill-owners are placed by the disgraceful condition of these streets. For at least one-half the year a team of horses are unable to draw more than a ton or a ton-and-a-half, at a slow and toilsome rate of speed, while with a good pavement the quantity could readily be more than doubled, greater speed attained, and with much less wear and tear of stock.

Doubtless the Board of Aldermen have been deterred, in this matter of street improvements, by the facility with which persons applying therefor have, under the decision of the courts, been enabled to evade the payment for such improvements. It is not for me to suggest how these improvements should be made; at whose expense; whether by the property owners on the line of the streets improved, by the city at large, or jointly. Your honorable body can, without doubt, arrive at an equitable and just distribution of these burdens, the undertaking of which, it must be apparent to all, cannot be much longer delayed, except to the permanent disadvantage of the city.

THE SHORE LINE.

Nothing has been done during the past year in refer-

ence to establishing a "shore line" or a limit beyond which erections either of buildings or other encroachments, on the river passing through the corporate limits, will not be allowed. The reason is, because of the very limited sum allowed by ordinance for the payment of assistants, which is inadequate even for the usual current work of the year, and to which subject I shall take occasion to refer before closing this report.

The importance of defining this limit and at as early a date as possible cannot be too deeply impressed upon your Honorable Board and upon our citizens. All experience has proved that men will not be restrained from present greed, by the anticipation of future possible injury or loss. That streets and highways have continually been encroached on for the most trivial reasons, and when the land gained has been too insignificant to be worthy of the consideration of any, but the most narrow minded, is a matter of history. The same unrestrained greed has infringed upon navigable waters throughout the land, in the erection of docks and gaining land from the proper and necessary water limit, until great and in some cases permanent injury has resulted to harbors, and commerce and navigation imperilled or destroyed. The banks of the Passaic in Paterson have presented no exception. Encroachments have continually been made, until the width in the more thickly built part of the town is quite inadequate for a safe conduit of the water in even ordinary freshets, and in times of great freshets endangering life and property. And as a natural consequence, most of the complaint for damage and discomfort, comes from the very possessors of the lands so unlawfully gained and which has been the direct cause of the difficulty. These encroachments will not be discontinued, until the limit beyond which erections will not be allowed, is defined and enforced.

The entire shore line of the river within the city limits should be surveyed as a whole, having a regard to the fall in the stream, and the necessary width provided, to insure a safe passage of the water during times of freshets, all encroachments beyond the lines necessary to give this width, and as mapped and established, noted, their removal provided for and the requisite steps taken to prevent further encroachments. Ordinances should be passed restraining all persons from depositing earth, ashes and all solid refuse matters in the river under severe penalties. Means should be taken to remove all deposits of sand and earth at the mouths of sewers, carried down as such materials must be from the unpaved streets.

An Oil Pipe Three Hundred Miles Long.

The Pennsylvania Transportation Company, of which Mr. Henry Harly is president, has been chartered by the state of Pennsylvania for the purpose of transporting oil from the oil regions to the principal Atlantic seaboard cities. The plan proposed is to run the oil through a four inch pipe laid on the surface; the forcing pressure will be nine hundred pounds to the square inch; there are to be stations at distances of fifteen miles, at each of which an engine of a hundred horse power will be erected to work a pump to continue the flow from point to point. The company having decided upon the construction of the work, the president sought the services of General Hermann Haupt, of Hoosac tunnel fame, and who, during the war, was Chief of the Bureau of Military Railroads, and a hydographical engineer of great skill and experience. He pronounced the scheme, after a thorough examination, to be entirely practicable, and he is now acting as engineer-in-chief.

In view of the enormous product of oil in this country—thirty thousand barrels per day—and the rank it now holds among the leading articles of export, coupled with the exorbitant charges for railroad carriage from the wells to the seaboard, by the completion of the enterprise and its successful operation, a complete revolution will be accomplished in the handling of this article.

As a proof of how valuable this traffic has been to the several railroads over which the oil has been borne, it is only necessary to say that up to the present time the railroad charges aggregate seventy-nine millions of dollars. The minimum cost of transporting oil by rail is fifty cents per barrel, and the minimum cost by the pipe process is sixteen cents. The average charge by rail is one dollar and a quarter.

The estimated cost of the entire work, including fixtures, etc., is one and a quarter million dollars, and considering the difference in cost between this method and that by rail, upon the hypothesis that the company will discount at least twenty-five cents a barrel on rail rates, it will be readily seen that with all the expense of operating, the first year's earnings will pay the first cost of the work.

The Pennsylvania Company is the parent company, but there is also the Baltimore Transportation Company, chartered by the state of Maryland, and some five other companies are expecting to unite. The first objective point or terminus will be Baltimore, as being the most feasible and direct route for the pipes. Following which other termini will be established, in Philadelphia, New York, etc.

The pipes being laid on the surface and there being no obstacle in the way of forcing the oil to any height, the line will literally be an air line, and the distance from the oil regions to Baltimore is three hundred miles.

The oil will be distributed from the pipes into immense reservoirs with refining establishments adjacent. Of course the whole railroad system will oppose it, for it is taking from them a traffic from the very nature of which there could be no competition, but the advantage to the oil producers, who will have the entire control, will be immense, and the advantages which will accrue from such facilities to this important branch of our export commerce will be incalculable.

The feasibility of this enterprise, so far as the passage of the oil through pipes is concerned, has been fully established by the present system in operation in the oil regions, where the aggregate length of the pipes conveying the oil from the several wells to the reservoirs is nearly two hundred and fifty miles.—*Boston Traveler.*

Water Pipes for Rio Janeiro.

A contract for water pipes has just been placed in Glasgow, which for its extent, its money value, and its importance from coming just at the very time when it was most wanted, is, we believe, quite unparalleled in the history of the pipe-founding trade. It is one for 80,000 tons, and is intended for a great water supply scheme which is projected for the city of Rio Janeiro, and we understand that the contract price for the pipes delivered at that port is about 1,700,000*l.*; so that in various respects it is an order whose importance can scarcely be over-estimated in the present depressed condition of most branches of the iron industries. As many of our readers are well aware, Glasgow has long been the principal seat of the pipe-founding trade, both for our extensive home demands and for exportation to almost all parts of the world. For a long time that branch of trade has been very busy, but latterly the various pipe-founding firms have been growing anxious as to the immediate future. This contract, however, now removes much of the anxiety which existed. When it became known a few months ago, that there was a contract of very gigantic proportions for water pipes about to be thrown upon the market, pipe-founders both at home and abroad, iron merchants, and other interested persons, did their best by instituting inquiries and opening negotiations to determine the direction in which it should go; but when the principal contractor become thoroughly assured that in Glasgow alone were there the requisite facilities for taking in hand such an immense order, so as to execute it with the necessary promptitude and on such advantageous terms as seemed in his eyes to be a *sine qua non*, he showed a leaning in favor of the offer from that city. Practically, we believe, there was only one genuine offer from Glasgow, because it was found that the order was of such unusual proportions as to require that it should be taken in hand by the three leading pipe-founding firms in alliance. Eventually the order was taken by Messrs. R. Laidlaw and Sons, for themselves, and by concert with Messrs. Thomas Edington and Son and Messrs. D. Y. Stewart, both of which firms have such facilties for a large turn-out in this branch of manufacture as are not excelled, if even equalled, by those of any other firm in the kingdom. For several years they have been jointly engaged in carrying out some very large water works contracts, and now for the first time in connection with such contracts there are to be leagued together no fewer than three eminent firms. The scheme for furnishing Rio de Janeiro with an abundant supply of water is an undertaking of the Brazilian Government, and all the capital for carrying out that undertaking is to be provided exclusively by Brazil out of her own resources, without the necessity of having recourse to the London money market. The chief contractor is Signor Gabrielli, an Italian gentlemen, but also a British subject. He is well-known as a contractor, three of his undertakings being the Vienna Water Works, and the new dock works at Malta and Chatham. There are to be two conduits leading from the reservoir or source of supply to the City of Rio de Janeiro, and the present contract is limited to supplying the pipes for the same, the area of distribution within the city being already completely and efficiently laid with mains. The pipes just contracted for are chiefly 3½ inch in diameter, only about 10 per cent. of the whole being of smaller sizes. Within the next couple of months or so the delivery will be commenced, and it will be continued in regular quantities over a period of two-and-a-half years from the time of closing the contract. As this is such an exceptional stroke of business in connection with the iron trade we feel bound to offer our congratulations to the Glasgow pipe-founders who have been so fortunate in securing the order. Let us hope that it may be a profitable one to all concerned.—*Engineering.*

Railway News.

Ground was broken at Dixon, Ill., on the 24th ult., for the Rock River Valley Railway.

The Pekin, Lincoln and Decatur Railway company was organized at Springfield, Illinois, on the 24th ult.

The Southern Pacific Railway Company has contracted for the building of the great bridge across the Colorado river, at Yuma.

The Wisconsin Central Railway is being pushed rapidly northward. The track layers will reach Elk River between the 15th and 20th of August.

It is likely that the proposal made by the Grand Trunk for a complete fusion of the Great Western and Grand Trunk Companies will be carried out.

The contract for rebuilding the Huntington Avenue bridge, over the Boston and Albany Railroad, substantially out of old material, has been awarded to Edmund Rice & Co. for $20,000.

It is said that the locomotive shops of the New York Central and Hudson River Railroad Company in New York are to be removed to some station between New York and Albany, as soon as the present lease expires, which will be next fall.

The San Fernando Tunnel through the San Fernando Mountains, on the Southern Pacific Railway, is 6,966 feet, or one mile and 1,686 feet in length. The character of the rock is such as to necessitate a lining of masonry of great strength.

The subject of building a narrow-gauge road to connect Cincinnati with Venice, Butler County, via Mount Airy, either from South Cumminsville up West Fork, or from the Cincinnati, Hamilton and Dayton Railroad Depot, in Cumminsville, up Badgley Run, has been talked over some time, and, accordingly, a meeting of the solid men of Mount Airy, Venice and Cumminsville was held at the school-house in Mount Airy, to take the matter into serious consideration, and ascertain what could be done towards giving the project a start.

Work on the Toledo end of the Columbus & Toledo Railway has been sadly interfered with by the very moist condition of the weather. It was expected at the opening of the season that the grading would all be completed, ready for track-laying, by the first of July, but the continuous rains have so interfered with operations that the work is some 60 days behind hand. However, it is expected that by good management and dint of push, track will be laid the entire length by the first of November.

Articles of incorporation were filed with the Secretary of Colorado on the 25th inst. of the Trinidad, New Mexico and San Juan Railway Co., to run from Trinidad to Taos, New Mexico, and Parrot City and Silverton, Colorado. There is also a prospect that the Denever and Rio Grande road will soon be extended southward from El Moro to Cimmaron or some other point in New Mexico. This action is hastened by the recent aggressive attitude assumed by the Kansas Pacific in pushing their branch southward.

Contractors' Intelligence.

Contractor Beaumont, who has been employed on the Hoosac Tunnel line railroad work at Shelburne Falls, Mass., fails for $20,000 and has small assets.

The new Central Avenue bridge over Neponset river at Tileson & Hollingsworth's paper mills is to be 60 feet wide and 158 feet long; the contracts have not yet been awarded. The contract for the abutments has been awarded to Fredrick J. Fuller, of Quincy, for about $8000.

We learn from Halifax. N. S., that a contract for the construction of the Eastern Extension Railway from New Glasgow to the Strait of Canso, with a steam ferry across the Strait to Cape Breton; also for a branch international railroad from Truro to Pictou, has been awarded by the local government to H. Abbott & Co.

The contract for the plumbing and gas fitting for the Michigan State Capitol, at Lansing, has been awarded to Messrs. Waite & Williams, of Toledo, Ohio. The Capitol building was commenced nearly four years ago, and will be completed December 1st, 1877. There has been $1,700,000 appropriated for the erection of this building by the Michigan Legislature, and the entire cost, when completed, will be between two and two and a half million dollars.

Chas. H. Strong, C. E., of Cleveland, O., is engaged upon the construction of the breakwater for the protection of the harbor of that city, the contract having been awarded him last September, by the United States Government. Some seven hundred feet of piling have been driven during the present season, The total length of the breakwater is about one and one half miles and its estimated cost $1,500,000. From the nature of the work it is hardly probable that it will be completed for a considerable number of years.

The West Chester Park extension includes the building of two bridges, one over the Boston & Providence Railroad and one over the Boston & Albany, and the filling of a long stretch between. The contract for filling has recently been awarded to Erza G. Perkins for $50,000. The work on the two bridges was begun about the first of June, but is not progressing very rapidly. Michael Mehan has been awarded the contract for the abutments. The bridge over the Boston & Albany road has been contracted for by the Leighton Bridge and Iron Works Company of Rochester, N. Y., for $110,000, and the one over the Boston & Providence will be built by the Delaware Bridge Company.

Work has fairly begun on the new Dover street bridge, Boston, by George H. Cavanaugh. The contract price for the bridge, exclusive of the draws, is $70,000, and the work will probably occupy till December. The structure will be of oak and southern pine. The roadway will be 43 feet wide, and the sidewalks on each side will be eight feet wide. There will be two iron sliding draws similar to the Federal street bridge draw, and they will be moved by horse power. The bids for these will be closed to-day. Mr. Cavanaugh's contract includes the building of two siphons for Cochituate water. These will be sunk fourteen feet below low water mark, will be 150 feet long, and when ready to be sunk in position will weigh 90 tons each. The city will furnish the pipes.

The Resources of Oregon.

We abstract the following interesting account of the rivers, railways and general resources of Oregon from one of our far-west exchanges:

The population of Oregon is not far from 108,000 souls. The commercial emporium of the state is Portland, with a population of 15,000, situated on the Willamette River, thirteen miles from its junction with the Columbia.

The principal river is the Columbia, which is navigable throughout the year to the Willamette, one hundred miles from its mouth; and thence eastwardly with two interuptions, the Cascades and the Dalles, where there are railway portages, to Priest's Rapids in Washington Territory, 396 miles from the ocean; and on its tributary, the Snake River, to Lewiston, in Idaho, 470 miles from the Pacific. The Willamette is navigable for ocean steamers and sailing vessels to Portland, 110 miles from the sea, and for river steamers for one hundred miles, during six months of the year. The obstruction caused by the falls of this river at Oregon City has been overcome by means of locks. Several tributaries of the Willamette are navigable during the winter season.

There is regular communication by ocean steamers between Portland and San Francisco, Washington Territory, British Columbia and Alaska; and by river boats to all points on the Columbia and Willamette rivers.

The Oregon & California Railway is now complete to Roseburg, in the Umpqua Valley, a distance of two hundred miles. From Roseburg a stage route, 275 miles long, leads to Redding, in the Sacramento Valley, the present terminus of the California railway sytem. Another railway, the Oregon Central, is in course of construction from Portland up the west bank of the Willamette River, fifty miles of which are already completed and in operation.

A cargo of wheat can be shipped from Portland, Oregon, to Europe, for less money than from Chicago, the great grain market of the west. During the harvest years of 1874-5, fifty-five cargoes of wheat and flour were shipped from Portland direct to the United Kingdom.

The governor of the state in his last message to the legislature, delivered September 16, 1874, says: "The value of our exports has reached a sum certainly exceeding $10,000,000. I estimate the export value of our wheat and flour at nearly $4,000,000, gold; of oats, other grain and fruits, $1,000,000; of wool, hides, meats, cattle and horses, $2,000,000; of salmon, at $1,500,000; of lumber and coal, at $1,000,000; of gold, silver and iron, at $1,500,000. This exhibit for a population of one hundred thousand is almost without a parallel." It is one hundred dollars for every man, woman and child in the state.

The Hudson River Tunnel.

Active preparations are now in progress for the construction of the Hudson River Tunnel on the Jersey shore. The entrance to the tunnel is located on Jersey Avenue, near Fifteenth Street, and the excavation will be carried in a north-easterly direction, terminating in Washington Square, New York. The tunnel will be two miles in length, and it is calculated the cars will pass through it in three minutes. The road bed will be twenty-three feet in width. The shaft at the foot of Fifteenth S reet, Jersey City, is 100 feet in circumference and the brick wall is three feet and four inches thick. The shaft has been sunk to the depth of twenty feet, and will be further excavated to the depth of sixty-two feet, when the excavation beneath the river will be commenced. The machinery for the work is now in position, and it is stated that the excavation of the shaft will be completed within twenty days. The eastern grade of the tunnel is two in a hundred feet, descending from Jersey City, then ascending on the New York side two in a hundred feet. As soon as the shaft is sunk to the required depth a few feet will be excavated in the tunnel, when an iron cylinder with hinged doors will be inserted, so that the laborers can proceed with the work. Compressed air will be forced from the surface into the cavity. Very little blasting will be necessary, the first vein of rock being 1,100 feet from the New York side, and the rock is soft. The depth of earth over the masonry will not be less in any part than thirty-five feet, so that no injury can occur from the anchorage of vessels. The cost of this stupendous enterprise will be $15,000,000, of which $10,000,000 has been already subscribed. After several legal contests the Hudson River Tunnel Company has been triumphant, and the president, Colonel Haskin, declares his determination to proceed vigourously with the work.—*New York Herald.*

Machine Tools at the Philadelphia Exposition.—No. II.

In the present article it is proposed to set forth, in as brief a space as possible, some of the causes which produce those characteristics of American engineering practice which we pointed out in our last number. It might be said that in cases like the present, when facts and results are arrived at, there is nothing gained by searching after the causes which have produced them; but such a view is wrong if any permanent good is to result from an exhibition. It there is anything to be either imitated or avoided, no assistance can be greater than to understand the conditions which have produced what is shown.

What is correct or even indispensable in one country may be wrong and inapplicable in another, owing to the differences of material, climate, labor, wants, and so on, and the conditions of the country should, as before pointed out, form an element of considerable weight in either estimating or adopting machines or processes shown at Philadelphia.

The first thing to be noticed is the insular position of America. It is cut off, as it were, from the rest of the world where similar industries and pursuits exist. The amount of travel which passes between Europe and America does something to acquaint engineers and manufacturers with the improvements and changes made in each country. The scientific press does more. But these means of information reach only the travelling and reading classes, and leave, as we very well know, erroneous opinions existing about many things. Nothing acquaints the people of one country with the industry of another like an exchange of products, tools, and machines. There is, in fact, no other way of rapidly and thoroughly introducing new improvements into a country. The American estimate of European industry is especially wrong, as it generally confounds North with South Europe, and is, moreover, in many cases based upon wrong premises. It is no uncommon thing to meet those in America who imagine certain manufactures to have been founded and begun in their own country, which, on the contrary, had been long and well practiced in Europe previous to the time of their introduction in America. These things are alluded to here to show the results of an isolation from the records and examples of Europe. There are not more than six places, we believe, in America where copies of British or other foreign patents can be examined, and the Government, instead of promoting inquiry into the industries of other countries, seems intent on shutting out such information.

A duty almost proscriptive is fixed on machinery imported into the country. Even the exhibited machines sent to Philadelphia from foreign countries cannot be sold except by payment of a duty by the purchaser. An American manufacturer or engineer who wants to purchase an example machine to be tested with his own or as a model from which improvements can be gathered, must first pay the value of the machine and then twenty-five per cent. additional to his Government for the privilege of buying that which is to promote home industry. If the expense of constructing machine tools was greater in America, there might be some reason for such a tax, but the fact is that many kinds of machine tools are cheaper in America than in Europe, if estimated by their capacity, and we venture to say that there will be few foreign machines exhibited at Philadelphia which cannot be made in America at the prices obtained in Europe, and this notwithstanding the enhanced price of labor, material, and other elements of machine-making, caused mainly by the tarifl.

These circumstances should not be lost sight of in accounting for much that is peculiar in American practice, or, as we should say, much that is wanting in that practice, because if in America, as in most European countries, examples could be imported free of tax, there is every reason to believe that still greater progress would have been made in many kinds of manufacture.

Another, and perhaps the principal cause which operates to produce so much originality as is seen in American tools and machines, is what may be called individuality, the propensity for acting for oneself instead of in combination with or in deference to precedents. This faculty of mind which pervades all classes, and more or less affects every branch of manufacturing industry, is nearly the opposite of that spirit which in Europe has fostered trades-unionism. Individualism exists of course in all countries in a greater or less degree; without it the standard of workmanship would be lost, and self-respect destroyed, but nowhere else have the circumstances of a country produced and maintained independent action so much as in America, and nowhere else have the results been so marked. The principal causes of this self-reliance have been in the circumstances attending the settlement of the country, an isolation from precedents, before mentioned, while perhaps something is due to the form of government. With the causes, however, we have nothing to do here, farther than to

trace particular results in engineering practice.

Causes which produce change must, at the same time, render change easy and possible; a corollary is that facility of change leads to instability.

The individualism which in America leads to incessant innovation therefore produces instability in machines and processes of manufacture. This is a matter to be well considered in examining and forming opinions of American practice; it is an element which determines in no small degree the designs and workmanship of machines and tools; their life is short until superseded by improvements, and it would be thought folly to waste material and labor in securing a little extra advantage in the operation of a machine which it is expected must soon make way for another. This is of course a rule with many exceptions, nevertheless one which directly or indirectly has greatly influenced the quality of material, workmanship, and durability of machines. In some branches of manufacture the nature and quality of material has had considerable influence in modifying implements and processes. In the manufacture of wood, for example, the material worked has, by reason of dimensions and quality, and various exceptional uses to which it has been applied, produced tools and machines scarcely known in Europe. "Bent work," a branch of considerable extent and requiring many special machines, is enabled to exist only by the long straight-grained and tough timber found in America. Planing machines for wood require to be nearly twice as large, or to work double as much surface as in Europe, and fixed cutters are not employed. Wooden vessels are employed for many purposes where metallic ones are used in Europe. In the city of Chicago alone there were consumed during 1875 nearly two and a half millions of barrels, kegs, firkins, &c., for packing merchandise.

The nature of the market for which machines and tools are furnished is an influence which must also be taken into account in forming opinions of American practice. Nearly all machines and tools are sold within the country instead of being exported as in the case of English makers for example. The terms of sale are very different for this reason. If a machine is ordered in America by a responsible firm it is sent by the manufacturer, and a guarantee of successful performance is always understood as a condition in furnishing machines. A manufacturer may demand and receive payment previous to sending machines, but this in no way relieves him from the responsibility of a guaranteed performance, and if a machine proves imperfect it must be taken back and the money refunded. Public opinion and the good name of an establishment demand this. One maker of machines, near Philadelphia, who has been long in business, gives his customers the choice of returning any machine not proving satisfactory after a trial of thirty days.

To those in Europe who regard America as the land of bad faith and trickery, such things as these may seem strange, and it may be wondered how there can be standards fixed for determining when machinery is efficient and when it is not. A few words will explain this. First, buyers do not so often depend on those who furnish machines and tools, as in Europe, for opinions as to what is required for a certain work. Every one engaged in a business assumes to know, and generally does know, what is required in the way of machines and tools, and orders them accordingiy. Second, by reason of intercourse between manufacturers and workmen, the great amount of travel and other causes, nearly all the processes in the more extensive branches of work are generally understood. This is especially true of iron and wood manufatures. Any intelligent workman is expected to know what the performance of a standard machine should be, and the closer bond between employer and employed enables proprietors to avail themselves of the aggregated amount of knowledge represented in their works.

The market for machines and tools is, therefore, a very peculiar one in America, and orders are given and executed with a greater amount of good faith and fairness than it would be possible to maintain in a trade consisting mostly of export.

Competition is another among the causes which give characteristics to American practice, and while such rivalry should be taken into account in criticising machines, tools, and products there is but little to defend the aspect under which it appears in America. Legitimate competition, efforts to produce better work or even to diminish prices without lowering quality is, as the old saying teaches, "the life of trade," but a shameful copying of everything which reaches a successful sale, and often without the least change, is a kind of competition, if such it may be called, which is reprehensible in the highest degree. This kind of copying has in America been carried to an extent for which there is no parallel in Europe. The only protection in producing improvements is in procuring patents, and this affords but little safety from imitations. Damages for the infringement of patents are limited to the proved benefit which has accrued to the infringer by reason of his using a patented improvement. Suits at law are tedious, expensive, and as in all countries, uncertain, because of the difficulty of explaining technical matters to courts. One evil resulting from the patent system in America, and perhaps applicable to some extent in all countries having patent laws, is that an impression exists that whatever is not patented is public property, and at the mercy of all who choose to appropriate it. This is a state of feeling hardly agreeing with the argument that invention is a thing of natural right and like other kinds of property.

The most serious and damaging form under which this imitating practice appears in America, is in attempts to cheapen machinery and tools by employing inferior material, and omitting work which is necessary to insure durability and good performance, while the articles produced are represented as the same with those of better quality. This it may seem does not accord with the critical nature of the market just pointed out, but the pressure felt from a want of capital and the struggle to make small means reach as far as possible, does much to support a market for what may be called "sham" products. It is not for a moment contended that deceptions as to the quality of what is produced are more common in America than elsewhere, but there is more effort given to supplant excellence with saving. The price of a machine or tool is a matter of twice the importance in America that it is in Europe. The means of purchase are limited and interest on investments is also much higher, so that everything favors competition in price which generally is the same thing as competition in quality. With all this, however, there is maintained in many branches of manufacture that will be hereafter noticed, an excellence which has caused astonishment in all countries. Such articles are generally those where the quality is apparent and subject to constant tests—hand implements for example.

The influence of manners and social customs upon the engineering interest in America is considerable, not only in determining the cost of producing, but also the quality of what is produced. One or two things may be noticed without going far into the economical part of the subject, which is not intended here. The individualism before alluded to, and its effect upon the relations between employer and employed, is beyond doubt the main reason why the Americans can compete in prices while paying high wages for short hours. A day's work and the wages received for it are in America considerations exchanged between man and man, rather than between master and servant; to give a short day's work would in a sense bring the same ignominy to a workman that to pay in bad money would to an employer. The distinctions of social life which must exist in all countries, are not in America carried into the workshop and countingroom. For an employer to give workmen a holiday, or in any other way pay them for hours not worked would be resented with scorn. There is but one incentive which will produce good and efficient work, and that is an idea of equitable exchange, and the sense of self-respect in workmen. These things are taken advantage of in America, and the result is that labor there paid at one shilling an hour, produces cheaper work than labor of the same kind at threepence an hour can do in several countries in Europe. Three thousand miles of expensive transport does not hinder American engineers from successfully competing with Swedish firms who have copied their machines. The difference in the quality of labor cannot of course account for all this, attendant conditions must be taken into account, such as the improved processes which the American system encourages and the European system repels. Lost time from holidays, dissipation, and many other things, go to make up the difference.

The vast extent of the country, diversity of climate, products, and wants, the intermingling of many nationalities, a vast system of inland navigation, the constant emigration from east to west which is going on, with many other things which could be named, all tend to give a peculiar stamp to mechanical industry, just as they do to manners and customs. There remains, however, one thing to be noticed, which is the scarcity and rental value of capital, briefly alluded to in a former place. The amount of capital in America is in the aggregate large, but spread out over the vast country, and estimated in proportion to the uses and wants which exist, there is a great scarcity. This consideration is unquestionably one which more than all others gives a peculiar stamp and character to American practice.

To trace the ultimate effects resulting from high rates of interest on capital in America, would be a matter of some difficulty, and is not to be attempted here. One or two only of the most prominent will be noticed.

A paucity of capital generally tends to concentration. We are apt to say that where wealth is plenty, vast works are possible, and will be built, but on the contrary, as facts in America prove, monopoly by concentration is more apt to be a result of a scarcity of capital. No one person being able to found a large business, many join together, and the result is not only a concentration of capital, but a concentration of skill, judgment, and that power due to organization; hence in America where capital is scarce, we see the largest works and monopolies, some of which are oppressive in the highest degree. One only need be mentioned, the manufacture of sewing machines. The "companies" sell their machines in London for a little more than half their price in New York; hence for the credit of having developed the sewing machine Americans have to pay about twice their value for all machines purchased at home. The product is forced into Europe by skilled production, assisted by a tax on American buyers. The patents on which this combination and others like it are founded, have in many cases no force unless supported by influence and capital, are merely dumb figures set up to give an ostensible air of justification when smaller enterprises are crushed out by legal processes. This tendency to concentration and monopoly is no doubt an indirect result of the scarcity of capital and high rate of interest. The effect has been to improve certain branches of manufacture, but whether a similar progress would not have been made if there had been no combinations, and whether the public are finally to enjoy the advantages due to such improvements, are problems not easy to answer.

A theory of political economy is that profits are or should be as the interest on capital, but this rule does not apply to circumstances at this time existing in America. The profit realised from the manufacture of machines and tools is less than in Europe, that is, the price at which the products are sold is less different from the cost of producing. The plans for thrusting middlemen in between the producers and the consumers are not so perfect. The commissions exacted by mercantile processes are, perhaps, not one half as much in America as in Europe, so that comparing products by their final price to the consumer may not be a fair way of determining a manufacturer's profit; but there are other means of ascertaining the profits resulting from capital invested in engineering business, such as the growth and success of ventures, and popular opinion, either of which are more reliable than deductions from general statistics.

The disposition to venture on new enterprises is in America due to the rapid increase of demand rather than the realization of large profits. Every one wants to do business for themselves, and feels that whatever is produced must be absorbed somehow, hence money is borrowed at high rates of interest because of the risk, the amount is as small as possible because of this high interest, and the result is a demand for cheap machines and tools. The fluctuating market produced by the rapid development of a new country is one of the most difficult to supply, and everything considered, there is one conclusion to which every circumstance in America points, namely, that there has been an extraordinary adaptation of means to ends, and to estimate what has been done in the engineering arts in America, we should not be too hasty in applying the standards of older and different countries.—*Engineering*.

NEW METHOD OF IMPROVING HARBORS.

For many years it has been a serious question how to preserve the harbors on our Gulf coast. The conditions involved are in many respects similar to those on our northern lakes, the chief thing to be guarded against, being the closing of the mouth of the harbor or bay by the sand swept along by the littoral current. Of course the device usually adopted in such cases is some form of the parallel jetty, which, checking the current along the shore left the space between the jetties to be scoured out by the action of the tides and local currents or to be dredged where these were absent.

The storms of the Gulf are often quite violent, and structures of more than ordinary strength are required. All the ordinary forms of timber crib-work or pile jetties are precluded from the fact that they are soon destroyed by the teredo navalis, no method of preserving timber from their destructive ravages having proved efficient. Breakwaters or piers made of stone are not practicable from the great distance it would be necessary to transport the stone. Concrete blocks are quite expensive and only warranted when there are immense commercial interests to subserve which condition does not exist at present on the Gulf coast. It is very doubtful from the ease with which sand finds its way through the Port Said breakwater, if loose blocks of Concrete would be efficient, or if they would not entirely settle out of sight, as the Gulf sand is quite finely comminuted and well worn. At any rate some less expensive method must be found or else the number of Gulf harbors must be comparatively limited.

In 1874 experiments were commenced on a new method of construction at Galveston which is destined to be the most important Commercial City of the Gulf and to whom the preservation of her harbor is of vital importance.

We have watched these experiments with great interest and are pleased to record that they have met with such success as to warrant the inference that the harbor question of the Gulf States is already solved, and by a method of construction withal, quite economical.

The method adopted is by gabions placed in rows so as to form a training wall or jetty. The final form and method of construction adopted for these gabions is as follows: A bottom of two inch planks is first laid down, this bottom being 12 ft. long and six ft. wide, the ends being semicircular. In holes bored about the edges of this bottom pine stakes six feet high are placed. Between these stakes wicker-work of cane or willow is interwoven, and on the top is placed a plank covering similar to the bottom. The whole is securely nailed and two ¾ inch iron bolts pass from top to bottom, binding all solidly together. The bottom is covered with a layer of concrete and the exterior is plastered over with two coats of cement plaster which takes a firm hold on the wattling, and the whole left to dry for two weeks.

In the line of the proposed jetty guide piles are driven 24 ft. apart and the gabions mounted on flat boats and towed out, and launched in position by the guide piles. Through holes left in the top they are filled with sand by a sand pump. A fascine made of brush from the cane, is placed between the gabions in order to prevent the current which may rush through the crack left, and excavate large holes. Usually in front of the row of gabions a mat of brush held down by concrete blocks is placed and is found to prevent effectually any tendency of the current to undermine. If great danger is apprehended from this cause, two or three gabions may be formed into a spur at right angles to the main line and these spurs placed at intervals effectually prevent undermining. Should one row of gabions prove inefficient, as soon as the sand fills in back of them, a second tier may be erected back of and parallel to the first, and even a third may be required.

These gabions have withstood the severest storms of the Gulf without damage, and the preliminary works at Galveston, although comparatively limited in extent, have resulted in a much increased depth on the bar, and a notable protection of the end of Galveston Island. The cost of the gabions in place, with the present experience in construction, is about $5.00 per lineal foot. The estimate for Galveston Harbor was 37,000 running feet of jetty, two tier high, and 20,000 of spur-jetty, one tier high, to cost $489,740.

This is much cheaper than equivalent work can be done for on our lakes. Similar gabions here would be utterly destroyed by ice. The cement might be omitted as there is no danger from the teredo, but it would not hold sand and hence would be useless.

INVESTIGATION OF THE LAND SURVEYS.

Dr. Silas Reed, late Surveyor General of Wyoming, has been under investigation.

The committee speak of the old law, which required all persons taking a contract to survey public lands to be practical surveyors, and of the change which now allows one party, when a contract is taken by a firm, to be the moneyed man and unskilled. Of the regulation allowing this, the committee say:

"This regulation, made as is claimed, in pursuance of law, enables surveyors-general to award heavy contracts to favorites who have no knowledge whatever of the work to be done or of the manner of doing it, and who scarcely ever go into the field. As surveying contracts are always awarded at the minimum sums allowed by law, the profits realized are generally very large in proportion to the amount invested by the moneyed man of the firm. This system of partnership in surveying was somewhat improved by Dr. Reed, very much to the advantage of the moneyed man of the firm, who, as appears from the testimony, was not only not required to do any work, but did not sign a contract, give a bond, take the oath, or advance any money. Under the doctor's system the moneyed man did no work and assumed no responsibility. He was a silent partner, with nothing to do except to receive his share of the profits. This system was put into practical operation in the spring of 1874, when the first contracts were let by Dr. Reed after his re-appointment."

The committee goes on to state that several prominent parties were interested in these contracts, "and that Dr. Silas Reed, the Surveyor-General of that Territory, violated his official oath by awarding contracts for surveying at the maximum price, upon condition that the deputies would divide their profit with men who gave no equivalent for the money they received."

In conclusion "to prevent similar misappropriations in the future, the committee recommend that the law regulating surveys be so amended as to impose a penalty upon Surveyors-General who may award a contract to any one not a skilful surveyor, and also a penalty upon any person receiving a contract who may neglect or refuse to superintend the work allotted him in person."

It would appear that the system of letting contracts on our public land surveys was not all that could be desired. The conclusion is strengthened by the unfortunate history of the Department of the Interior for the past few years. We well remember the survey of the western boundary of Wyoming Territory which, although not properly under the head of land surveys, or necessarily connected with Dr. Reed, was let by contract by the Dept. of the Interior. The survey itself was an unmitigated fraud, no pains being taken with measurements for distance or any proper astronomical observations for direction. The contractor seemed anxious only to complete his job at the earliest practicable moment, and draw his pay. The boundary itself is probably out many miles. So it would appear as if there were some grounds for an investigation, if conducted in the proper spirit. We know nothing in regard to the present controversy except in a general way, *viz*: That the present law is very defective and gives ample opportunity for fraud. We clip the following from the Boston *Advertiser:*

"In regard to the report of the committee on expenses in the Interior department,—making a variety of false charges against Dr. Silas Reed, late surveyor-general, Dr. Reed, in a note to this paper says:—

....The surveying law was not violated, nor do the committee prove that it was. No incompetent surveyor executed a contract under me. No deputy received a dollar more than the price named in the law and uniformly paid by me for many years. My deputies stood high for honesty and capability, and executed the most thorough surveys to be found in the Rocky Mountain territories, which a ten years' experience as surveyor-general enables me to state without fear of successful contradiction," etc.

THAT misfortunes never come single handed is illustrated by the recent loss in the British iron-clad fleet. Whether these losses be due to ignorance or carelessness or both, for carelessness is more often due to ignorance than otherwise, it is not our province to determine. In the loss of the ill-fated Captain by capsizing, the result was one predicted by many naval constructors. The Vauguard was sent to the bottom by a collision with the Iron Duke resulting from the most culpable carelessness. Lastly the explosion of the boilers of the double-turretted iron-clad, Thunderer, on the 15th of July, while getting up steam for her official trial, has raised the question as to whether the officers of the British navy are competent to handle those engines of war which England's strife to maintain her naval ascendancy obliged her to build. Only 77 men injured of whom about 40 have died! Of course this is terrible in any case, but it amounts to little, if the proper lesson is learned. As to the accident itself. The vessel had eight boilers of the common low-pressure type. The safety valves were supposed to blow off at 30 lbs. The boilers themselves may have deteriorated during the lapse of three years when they were not in use. In the mean time, while speculation was rife, the official report developed the fact that when the boilers were tested by hydraulic pressure the steel wedges by which all the safety and relief valves were held fast, were not removed at the conclusion of the test. They were forgotten. We all know what followed, and yet, it did not happen in America. Such accidents carrries us back to the old times on the Mississippi. But those were days of unadulterated recklessness and not of ignorance and unmitigated carelessness.

SOME interesting facts have been established by the Challenger Exploring Expedition, which has just returned to England. At great depths in the sea the temperature always sank to near the freezing point of fresh water, and the conclusion is that the great mass of the water in the troughs at the bottom of the Atlantic and Pacific is derived from the Southern Sea. The deepest sounding made was in 4400 fathoms or about five miles. The depth of the Atlantic averages about 2000 fathoms, and that of the Pacific about 2500 fathoms. Over large areas the dredgings revealed large deposits of chalk or microscopical remains of organisms which all live within 100 fathoms of the surface. At a depth of 3000 fathoms, however, the bottom was found uniformly to be a species of red clay which could not be accounted for, as the surface was full of the chalk-producing organisms: "Whether it is decomposed pumice stone vomited out by volcanoes, or whether, lastly, it has something to do with that meteoric dust which is being continually rained upon us from the spaces of the universe," is equally a mystery, says Sir Wyville Thompson. The deep-sea fauna were found at all depths, although they decrease in number as the depth increases. The animals found were very generally diffused, though differing in some respects in the various localities.

THE appropriation asked for the harbor at Michigan City was $50,000, for South Chicago, $5,000 and for Chicago, $5,000. The first sum was intended to push the piers at Michigan City to an early completion as every engineer knows the necessity of pushing jetty work rapidly on a sandy shore in order to head off the deposits which are sure to make in the contemplated channel way. The two latter sums were merely for repairs to the piers, the harbor at South Chicago being in excellent condition and also the harbor of Chicago except the harbor of refuge on the lake front in which a considerable amount of dredging will have to be done in order to make it fairly available for our heavier lake craft. Let us see how the Senate in its inscrutable wisdom has revised the estimates. For Michigan City, $30,000, for South Chicago, $20,000, for Chicago, $5,000. Not enough for Michigan City to enable the work to be done efficiently and ultimately with economy, and the engineer-in-charge is cudgeling his brains to make clear to his mind what shall be done with the appropriation for South Chicago. Some can be used for the extension of the south pier and the rest will probably be used for raising corner lots above datum. Many people, and possibly the *Times*, or even the *Tribune*, would infer that some legislator, high in authority, had an interest in South Chicago real estate; but such suspicions are not of our mind. We can see in it the recognition that Chicago's site was located too far north by ten miles and statesmanship is endeavoring to right the accident.

BIDS FOR COOK COUNTY COURT HOUSE STONE.

It is not often that we feel called upon to ventilate a public steal, but during the week, a job of such magnificent proportions having been all but consummated and in such a glaring and barefaced manner, we feel justified in laying the facts before our readers in order that they may draw their own conclusions.

Some time since the County Commissioners advertised for bids for the stone for the county portion of the Court House and City Hall building, estimated to cost between three and four millions. These bids were to be based on an estimate of 317,000 cubic feet of stone, cut and set in the building complete.

The following are the most important of the bids:

LIMESTONE.

Patrick Fanning (Lemont)	$ 535,000
Wm. McNeil & Son, (Lemont)	540,000
Chas. A. Orleans (C. & W. Co.)	558,641
John Atkinson	580,000
Tomlanson & Reid (Lemont)	608,450
W. C. Deakman (Lemont)	612,641
Isaac Graveson	645,000
Earnshaw & Gobel	669,129
Boldenwick & Hennie	730,000
Seymour, Talcott & Co. (Lemont)	775,000
Chas. Messenger (Lemont)	946,260

BEREA (OHIO) SANDSTONE.

Isaac Graveson	$ 447,000
Patrick Fanning	500,000
Tomlanson & Reid	556,000
Earnshaw & Gobel	565,384
Boldenwick & Hennie	620,000
Ginley & Nunnemacher	689,900

AMHERST (CLEVELAND) SANDSTONE.

John Atkinson	$ 500,000
Patrick Fanning	530,000
Chas. A. Orleans	541,229
Wolf, Price & Kerber	575,480
Batchlor, Gibson & Smith	713,000
Boldenwick & Hennie	750,000

AUX SABLE, MORRIS, (ILL.) SANDSTONE.

Isaac Graveson	$ 426,000
John Atkinson	442,000
Wolf, Price & Kerber	472,892
Wm. McNeil & Son	481,000
Patrick Fanning	486,000
Tomlanson & Reid	495,000
Boldenwick & Hennie	580,000
Daniel H. Call	595,000
Ginley & Nunnemacher	597,000
Henry Harms	600,000
Batchelor Gibson & Smith	622,000

LAKE SUPERIOR SANDSTONE.

John Atkinson	$ 468,000
Wolf, Price & Kerber	496,872

BUENA VISTA SANDSTONE.

Isaac Graveson	$ 506,000
John Mueller	523,000

Thomas Cummings—Bedford limestone in the rough, 60 cts. per cu. foot for all sizes; with Wolf, Price and Kerber's bid for cutting, making in building complete, $601,000.

Edwin Walker, for Lemont limestone in the rough, for all sizes, average 87 cts. per cu. foot, and with cutting and setting aggregating $695,000.

We have had the pleasure of examining the samples presented, and certainly, from the lot, very excellent stone can be selected and the County Commissioners should have no difficulty in deciding, especially after a personal inspection at the bidders' expense.

Of the sandstone, the Lake Superior is undoubtedly too dark, and the Buena Vista has acquired a bad reputation in connection with the Custom House, although with careful selection it might do, as many buildings in this city are built of it and it stands well. The Aux Sable stone strikes us as being too friable, although it is said to be a good stone and especially adapted to stand fire. The Amherst stone is a handsome stone and has given satisfaction in this city and, in fact, in all the lake cities wherein it has been used to a greater or less extent. The Berea stone is a finer grain than the Amherst and certainly a most handsome stone and highly spoken of. The Berea or the Amherst is the best of the sandstone group for the purpose.

But two limestones, the Lemont and the Bedford, were offered. The Lemont is a magnesian limestone and has been much used about here. The Bedford, however, is altogether the handsomest and undoubtedly the better of the two, and is so admitted by all the council but two, and by most of the stonemen themselves. The experience with limestone in this city in the great fire was not favorable to its general use, and many would have doubts as to the propriety of its use at all.

Taking the lowest bids on those stones generally admitted to be available, they stand as follows;

Au Sable sandstone	—Isaac Graveson	$426,000.
Amherst "	—John Atkinson	500,000
Berea "	—Isaac Graveson	447,000
Lemont limestone	—Patrick Fanning	435,000
Bedford "	—Thomas Cummings	601,000

Here are five stones all supposed equally good and at reasonable rates, and the question now seems to rest on which will make the handsomest building, and whether it shall be limestone or sandstone. If sandstone, Au Sable is cheapest, but we should prefer Berea as a better and handsomer stone. If limestone, Lemont is the cheapest but Bedford is enough handsomer and better in every way for the purpose to give it the preference.

Let us see what was the action of the council. First they decided that it would be best to keep the money at home. Of course that excluded all but Lemont stone. Some are unkind enough to say that this action was determined upon before proposals were advertised for, and that "outside" men were invited to bid to give the appearance of fairness. Others assert that this protection of home industry had reference to the lining of commissioners' pockets. Be that as it may, supposing the council to accept the lowest limestone bid, the county would pay $50,000 for its paternalism, or if Berea stone was taken, $44,000. The committee go farther than that and give the contract to Edwin Walker for the sum of $695,000 or $160,000 more than Patrick Fanning's bid for the same stone; $269,000 more than Isaac Graveson's bid for Au Sable; $248,000 more than his bid for Berea; $195,000 more than John Atkinson's bid for Amherst, and $94,000 more than Thomas Cumming's bid for Bedford.

Their reasons for this action may be stated in brief: 1, Walker lives in the county; 2, He owns a quarry; 3, His quarry is extensive enough to furnish all the stone of a uniform quality; 4, The only quarry of Lemont stone from which stone of sufficient size can be taken, and lastly, as giving the other reasons greater weight, it is said he spent the most money.

The answer to the first is that Patrick Fanning also lives in this county. 2. He can furnish ample bondsmen. 3. He had made arrangements with the stone companies to furnish him with stone which can readily be done of uniform quality. 4. He can obtain stone of sufficient dimension and lastly, it is said that the pocket lining which he furnished was too thin.

Walker's bid is also informal on its face, and we understand his property is so mortgaged that the lien on his quarry would not be worth the paper on which it could be written.

We further understand that Walker's bid makes provision only for delivering stone in the rough at the dock, cutting and setting, the county, as soon as preliminaries are adjusted, to be at the expense of hiring a stone yard and hauling the stone to the building, which will swell his bid to $800,000.

Of course there was a wrangle in the committee but the vote was finally taken and deserves to go on record.

Ayes—Commissioners Carroll, Cleary, Conly, Johnson, and McCaffrey—5.

Noes—Commissioners Guenther, Lonergan, and Schmidt—3.

During the wrangle Commissioner Conley informed the members who now opposed the Lemont stone that they had promised to vote for that stone even if it came 15 or 20 per cent. higher.

Next Monday evening the report of the committee goes to the Board of Commissioners and but one result is anticipated, viz., that the report of the committee will be adopted.

To those who do not know the nature of the bid the following estimates will be of interest:

TO THE JOINT COMMITTEE ON PUBLIC BUILDINGS AND SERVICE—*Gentlemen:* In compliance with your request, I have revised the bill of quantities of rough stone required in the construction of Cook county court-house, with a view to determine the relative quantities of large and small stones required by the present contract, and beg leave to state that the quantities do not differ materially from those contained in the printed forms of proposal now before you.

The total quantity of rough stone required is 317,000 cubic feet, of which quantity 185,000 cubic feet may be classed as large stones, carrying from 25 to 100 cubic feet, so that nearly two-thirds of the stones are of the larger dimensions required by the plans, although not quite that proportion.

If the dome, the arches, and smaller domes should be built, together with the west half of the building proper, there would be required in all, that is to say, for the whole structure, 984,000 cubic feet of stone of all dimensions, of which quantity 634,000 feet, or twice the quantity certified in present proposals, would be required for the building proper, and 350,000 feet would be required for the large and small domes, and the arches complete.

Of the 350,000 feet thus required there would be about 150,000 feet of stone of the larger dimensions; that is to say, stones varying from 25 to 80 cubic feet. Very respectfully,

J. J. EGAN, Architect.

P. S.—If the dome is built to the roof level, about 300,000 feet will be required, and about 110,000 feet of this quantity would be stones varying from 25 to 100 feet.

When it is remembered that the bids were for 317,000 only, and that the county is likely to build the entire building, negotiations now being matured for that purpose, it would appear that this is likely to be one of the collossal steals of the age.

DRAINAGE FOR HYDE PARK.

The people of Hyde Park have been much exercised about the overflowing of land in the southern portion of that township, owing to the present high water in the lake. Recently a topographical survey of the town has been made by engineers Bristol and McLennan, covering the region from Sixty-seventh street to the north end of Calumet Lake. About 5,000 acres were found to be below Chicago datum, or about a foot and a half below the present surface of the lake, and much more so low as to be practically under water. Much of this land is at present valued at $1,000 per acre and would be doubled in value with efficient drainage. Various schemes are suggested for relief, the one most seriously considered being a broad ditch for the more elevated portion, and pumping works for the lower portion No doubt these schemes are entirely feasible and their estimated cost, $100,000, is moderate enough, considering the interests involved. At a meeting of the property owners, on Tuesday evening, the following was adopted which certainly looks as if the interests of what is destined to be a great manufacturing center will be conserved:

WHEREAS, It is quite apparent that ample drainage can be provided and established, and completely redeem the low lands in the southern portion of the Village of Hyde Park:

Resolved, That the wish and opinion of the property-owners at this meeting is that the municipal authorities take immediate steps to decide upon a sufficient and complete system of drainage for that portion of Hyde Park south of Sixty-third street, and that, after the adoption of the plan, every reasonable effort be made to carry it into immediate effect.

JUDGE Johnson has rendered his decision denying the motion for an injunction to restrain the further construction of the New York & Brooklyn bridge, on the ground of obstruction to navigation. In consequence work has been resumed with great activity.

IT is reported that a company is forming in Paris for the purpose of holding a great International Exhibition in 1880. It will be on the Champs de Mars and is to be, in all respects, a vast improvement on previous exhibitions. It is estimated to cost $7,000,000.

INDIA-RUBBER collectors have confirmed the report of Mr. Gogorza in regard to the low pass across the Isthmus of Darien. They report a gap through which canoes are dragged from the Cacarica river into the Paya, one of the tributaries of the Tuira river. These reports are also confirmed by a resident miner and by the Indians of the region. Surveys are to be commenced by Nov. 28th and a report made to the Colombian government within six months thereafter, when we shall know more definitely in regard to the feasibility of the route. All the news thus far is certainly encouraging, but we fear that Mr. Gogorza is doomed to disapointment on that route.

WE learn from the *Hydraulic Engineer* that a genius named John N. Poager, of Cincinnati, Ohio, has patented an idea which he may find not original when some engineer desires to use it. He proposes in the water supply of cities to employ two reservoirs, one situated at a moderate hight for service pressure, and another at a hight sufficient for fire purposes. Both of these reservoirs are to be kept full, either by pumping, or some system of gravity supply, when that is available. The patent laws are by no means an unmixed blessing. About every idea is patented and it is almost impossible for an engineer to make any combination or design for a piece of work without some shark who is always sure to be lying around awaiting such an opportunity, sueing him for infringement or a royalty. This would not be so

bad if the patentee would confine himself to original devices. But when he takes up old ideas or mayhap ideas which cannot be found in the Patent Office records, then it becomes an unmitigated nuisance. The patenting of an idea is wholly wrong except it be embodied in a construction. The idea of a man patenting a reservoir system which in itself is not new. First we know, some man will patent a method of building cities and running municipal governments.

On Aug. 8, the Chair laid before the Senate a communication from the Secretary of War, inclosing a letter from the Chief of the Engineer Corps, remonstrating against the proposed amendment to the River and Harbor Appropriation bill limiting the availability of the appropriation for the improvement of the Southwest Pass of the Mississippi River. He expresses the opinion that, if the amendment should be finally adopted, it will stop the work of dredging, and intefere with the commerce of New Orleans. In the present uncertain state of affairs at South Pass the precaution of the Chief of Engineers is undoubtedly proper.

"A New Pavement."

BY F. H. COBB, C. E., Washington, D. C.

[Written for Engineering News]

In your issue of July 22d, there is an article from the *Beloit Free Press* describing a new pavement patented by E. McDonald of Beloit. As about everything has been tried in Washington from a gravel road to Neufchatel rock, it was with peculiar interest that I read of this new competitor for roadway honor.

The article in question contains this paragraph, after describing the material: "But the chief and most important feature of my invention consists in the employment of metal bolts or plugs as shown, which renders the face of the pavement practically indestructable, and at the same time presents a sufficiently rough surface to prevent the wheels of vehicles from sliding thereon, and also giving enough roughness of roading surface as to effectually prevent horses or other draft animals, or even pedestrians from slipping thereon."

In regard to the first point. It is claimed that the introduction of iron bolts will prevent the wearing away of the surface, and thus preserve the wood for an indefinite period. This would be a proper remedy if that were the real trouble. But experience has shown in this city that it is not because of the wearing of the ends alone of the blocks, that the roadways become uneven but because of the rotting of the entire blocks. We have all the different varieties here, wood treated and wood untreated, but with one or two exceptions they have all proved a failure. I have yet to see a single instance, in which the surface of the block has worn any appreciable unevenness, where it was not caused by decay rather than travel. The few streets paved with wood (Cypress) which are in sound condition after four years use are a proof of this. The surface, except where settlement has taken place is as even as when first laid.

Any crack or crevice which admits water hastens decay. However closely fitting the blocks may be at first, the constant passage of heavy travel will tend to loosen them, and admit water into the very place where it is most destructible. So that while the bolts render the surface indestructible, they actually hasten the decay of the entire blocks. Among such woods as do not decay, I have shown that here at least no such protection is necessary. Perhaps some of the requirements of a pavement in Beloit do not obtain in Washington. We are seldom troubled with slippery roadways. To be sure there are times when great care is need in driving, but these are the exceptions. As a general principle it may be safely stated that no more accidents occur here on wood than on any other pavement. But admitting that this does exist to some extent, will iron bolts prove the proper remedy? Will they not themselves wear smooth in a short time and be worse than wood alone? We have in our city iron sidewalks and crossings, designed, especially by grooves and cross-lines, to prevent slipperiness. But they are always avoided on that very account, and nearly all have been removed. Then too the bolt heads will afford an uneven surface for the horses feet, being worse in this respect than small cobble stones.

On account of these things, Mr. Editor, it does not seem to me that this improvement will be a success.

Water Routes.

The following table in regard to the lockage and distances from Chicago and Duluth to New York and Montreal is of interest. The figures given on the Georgian Bay and Lake Simcoe ronte are all approximate and probably somewhat in excess.

INLAND NAVIGATION — FROM CHICAGO TO ATLANTIC PORTS.

	ROUTES.	Lockage.	No. of locks.	Miles canal.	Miles river.	Miles lake.	Total distance.
1.	Chicago to Montreal by the Welland and St. Lawrence canals,	553	54	71	185	1,005	1,261
2.	Chicago to Montreal by the proposed Ottawa canal	710	69	29	402	560	991
3.	Chicago to New York by Buffalo and Erie canal	655	72	352	202	865	1,419
4.	Chicago to New York *via* Welland canal and Oswego	955	94	224	196	983	1,403
5.	Chicago to New York *via* St. Lawrence and proposed Caughnawaga canals	717	72	158	363	1,116	1,637
6.	Chicago to New York *via* proposed Ottawa and Caughnawaga canals	872	87	125	572	671	1,368
7.	Duluth to Montreal *via* Welland & St. Lawrence canals	572	56	72	230	1,095	1,406
8.	Duluth to Montreal *via* proposed Ottawa canal	729	71	30	456	610	1,096
9.	Duluth to New York by St. Lawrence and proposed Caughnawaga canals	736	74	159	417	1,206	1,782
10.	Duluth to New York *via* proposed Ottawa and Caughnawaga canals	891	89	126	626	721	1,473
11.	Chicago to New York *via* proposed Huron & Ontario canal	1,178	125	222	191	775	1,188
12.	Chicago to Montreal *via* proposed Huron & Ontario canal	775	84	103½	174	760	1,037½

NOTES.

Supervising architect, Potter has resigned and Mullet resumes his place probably.

The introduction of water into Newburyport, Mass., is discussed. A public meeting will be held next week in favor of Holly water-works.

Dallas, Texas, is calling on New Orleans and Shreveport to give Northern Texas an outlet for her grain which has grown to be the principal article of export in that region.

The work of building the New York and Brooklyn bridge is to go on speedily if no further legal interference is made. It is thought the first wire will be stretched across the river this week.

The government lock at Eureka, on the upper Fox river, is completed, and is a very fine structure. Dredges are at work cleaning the channel, and by Sept. 15 the river will be open from Green Bay to Portage.

The new iron bridge over the Hudson river at Fort Edward, N. Y., was finished on Monday, a large number of hands being employed the major portion of the day in placing the girders in position and laying the track through the bridge.

It is said that a Bostonian has offered to supply the borough of Birmingham, Conn., with water by the Holly system, lay the receiving pipes, furnish material for a dam etc., for $45,000, and take pay in the borough's bonds, payable in twenty years, at six per cent.

Steamboating on the upper Mississippi is becoming difficult, on account of the low water. The bar opposite the landing at Madison, Iowa, has become quite troublesome. The $10,000 appropriated by Congress to improve the same will probably be ample to restore the channel to its prior course.

Ft. Wayne, Ind., is just now troubled with injunctions in regard to her water-works. Some of the citizens are trying to restrain the Common Council from letting the contract for their constuction to other than the lowest responsible bidder. Consequently there has been some excitement in Ft. Wayne.

For the present the work of dredging the river at Cleveland, Ohio, has stopped. Up to the time the work ceased 180,000 cubic yards of earth had been removed, which left the river with about fifteen feet of water, and in better condition than it has been before in many years. The work was being done at 14½ cents per cubic yard.

The work on the new dam of the Worcester, Mass. reservoir is progressing satisfactorily, and it is thought by the commision in charge that all danger from springs in the ground is past. Esek Sanders of Grafton has accepted the invitation to become a member of the mixed commission, in place of Mr. Charles E. Whitin, who declined to serve.

The production of crucible cast steel in the United States last year amounted to 39, 401 tons as compared with 36,328 tons in 1873. Open hearth steel was made in the United States last year to the extent of 9050 tons, as compared with 7000 tons in 1874. Other descriptions of steel were produced in the Unitee States last year to the extent of 12.607 tons, as compared with 9353 tons in 1874.

The work of clearing the new channel at Eagle Harbor, Lake Superior, will be completed in a few days. It is 60 feet in width, and will be marked by range buoys. The next work in hand at that point will be the deepening of the old channel, and when this is finished there will be a uniform channel 120 feet wide with sufficient depth to enable craft of the largest size to enter the harbor.

On Tuesday of last week the first stone of the new locks of the St. Mary's ship canal was laid with appropriate ceremonies. Gen. Wetzel inspected the stone, pronounced it properly laid and indulged in a speech which was followed by others all agreeing that this canal is destined to be the way of a mighty commerce. The business through this canal in 1875 was 1,290,729 tons. The locks are built on a new plan and the sluice-ways are situated under the floor, the filling of the lock taking place from the bottom.

The Syracuse *Journal* says that it is a prophetic fact that very few first-class boats are now seen on the canals of New York, and as none are being built nor likely to be built while the present depression continues, it follows that the day is not far distant when there will be but very few boats of any kind fit for use. There is now no inducement for building boats, and owners of new ones cannot earn the interest on the capital invested. The railroads seem determined to ruin the canals, and with the assistance of state officials high in authority are making good headway.

At a meeting of Chicago and Clinton capitalists, at Clinton, Iowa, August 4th, a company was formed to construct a pontoon railway and wagon bridge across the Mississippi, under the act of congress passed two years ago. The bridge is to be similar to the one at McGregor. There will be $100,000 stock; nearly that amount is already taken. Engineer J. E. Blunt, of Chicago, is engaged to make surveys at once and locate the bridge. It is expected to build it within the next few months. The bridge, besides affording wagon way across the river here, will give the Prophettown branch of the Burlington railway and the Western Union railway entrance to the city, previously denied by the Northwestern Railway Co., controlling the present bridge.

Two mortars, intended for use in connection with the life saving stations at this port and Grosse Point, have arrived at Chicago and are thus described. The mortars are a little over one foot in length. They rest upon iron beds of great strength, 12 by 18 inches in length and breadth, and are inclined at an angle of 15 to 20 degrees. they have a bore six inches in diameter, with an inner chamber for the cartridge. Each mortar is provided with 12 24-pound balls. These balls all have strong wire arms, fitted in grooves, to which the rope intended to be carried to a stranded vessel can be attached. The rope will in reality be fastened to a spring about a foot in length, and this spring hooked on to the ball—the spring is intended to relieve the rope from the sudden great strain that it would otherwise be subjected to when the ball is projected from the mortar. The rope used in connection with these mortars will be small, the object to be accomplished with it being the same as is accomplished by heaving lines on steam and sail vessels, viz.: to assist in getting a larger line to a vessel.

Engineering Instruments at Philadelphia.

[Special Correspondence of Engineering News.]

I.

Those who will take the trouble to examine the articles exhibited, of the class above named, will find evidence of successful effort to improve, in various ways, the instruments in common use, by the invention of various devices, the most important of which are the following: a higher power and greater definition in the telescopes; better and more complete means of adjustment, and greater adaptability of construction and size to the purpose for which the instrument, whatever one it may be, is to be used. Very likely other improvements may be found as our examination of the exhibits made by the different makers proceeds.

I first called at the collection of W. and L. E. Gurley of Troy, N. Y. As many of their instruments are used in the West, the readers of the NEWS will, no doubt, be pleased to learn what they are doing. I was very courteously received by Mr. Arms, the representative of the firm, who took every pains to have me see and understand their work. As a matter of curiosity, the first thing he showed me was a transit, of their usual pattern, made of aluminum. This instrument was practically as heavy as a glass one would be. It was a surprise to lift it. Since this metal abrades so easily, and since the method of brazing it is as yet unknown, at least to these makers, there was some ingenuity required in its construction. The graduations are upon silver and the bearings are all hard bell-metal. I was informed that fifty per cent. of the price of the common brass instrument was added to buy one of these. Whilst the metal is about as costly as silver its lightness enables the makers to offer them at the price named.

I was then shown Pearson's Solar Apparatus which is added to a transit instrument so as to enable the user to run by the sun as with the solar compass. For the benefit of those who do not understand this addition to a transit, I will say that there is a short axis secured to the transit axis, perpendicular to the plane of that axis and the center line of the telescope. This short axis is the polar axis of the instrument when it is used as a solar transit. To this polar axis is attached the usual declination arc. To use the instrument as a solar transit, the levelling is done by means of the long level on the telescope, the latitude is set off on the vertical limb, and, the sun's proper observed declination being set off on the declination arc, the instrument is "set" exactly as a solar compass would be. When the instrument is once set the lower plate is clamped to the spindle; the telescope may then be moved and the work carried on from the lower plate as a base. It seems to me that this arrangement possesses certain advantages over the old arrangement. These are as follows: great reduction in the level error; fewer and more easily made adjustments, and less liability to get out of adjustment. It is well known, and to no one better, perhaps, than to the Messrs. Gurley, that there is at least one very difficult and tedious process in the construction of the common solar compass. That is the process of insuring the parallelism of the axis of the latitude arc to the plate. This is not the only one but there is not space here for more. In the new arrangement of course this difficulty is avoided, for the transit axis fulfills the office and it is not very difficult to put that at right angles with the vertical axis. Now whilst there are these manifest improvements there yet remains one important matter unexplained. How is the polar axis of Pearson's Apparatus adjusted at right angles with the transit axis of the instrument upon which it is placed? This question I hope to see answered in ENGINEERING NEWS, and not only the process, but the whole apparatus, illustrated. It seems to me that there has here been made a great improvement upon the solar compass. Great accuracy is claimed for it by different users. I hope that an exhaustive series of tests will be made and published regarding it, to which I shall be glad to lend any aid that I can, and I would here suggest a method for such tests if I had not already devoted too much space to this matter.

My attention was next called to the method of making pivot caps or rests for compass needles. These are now made of steel and are considered far superior, by the makers, to the ordinary agate, ruby, or sapphire centers. The stone caps had to be worked out to the form of a flat hollow cone. The tool that did this cut very slowly and imperfectly at and near the vertex of the cone. It was very difficult to get perfect caps. They were rejected in great numbers. Now a certain grade of steel is used, of which Mr. Arms could not give me the name. A piece of this steel is prepared of the proper size in the soft state; an indentation is made in it on the proper side by a highly polished and hardened punch of just the right form to fit into a cap, after which the steel is hardened by the Mercury process. Of course the right shape is obtained at once and it is only necessary to rub up this surface somewhat. Now whilst the pivot is as hard as fire and water will make it, and have it stand, this cap is harder. Few or nearly none of these caps have to be rejected upon trial, and of course all appreciate the value of superior mountings for a magnetic needle. If the test of use shall substantiate the claims of this cap it will certainly be quite an important matter. I believe they have been out for a year or two, perhaps more, already.

I was also shown a neat little arrangement of a reel inside of a plumb-bob for winding the string upon by simply turning the knob that usually sticks up out of the top of a plumb-bob. It worked very rapidly and nicely. When the string is to be lengthened just pull on the plumb-bob.

There is also shown an apparently good adjustable-legged tripod for mining transits, and for use upon very rough ground. It is very stiff and well secured.

But the best exhibit of all was the manifestly earnest desire to do better work and give better satisfaction. Whilst my experiences with some of the work of this firm have not been pleasant I am much pleased to be able to assure those who read this that all I saw and heard was such as to give me confidence in their endeavors to please at this time. Indeed it may become evident upon slight investigation that any firm that means to succeed in the manufacture of engineering instruments now, must seek to do a high class of work in their department. This I believe this firm are now doing.

I next examined the work of James Prentice of 164 Broadway, N. Y. Here are shown the instruments in common use. No new devices were apparent upon a short examination. The instruments are shut up in a glass case and no one was present to show them. They are of *solid* construction. All the separate pieces of a transit are shown neatly laid out for inspection. This may be an object for those engineering students, who never saw the like before, to visit the case. There are yet many schools where they teach *about* these things but do not teach the things themselves as Coleman Sellers demands they be taught. There is also in this case one of those wonderful seventy-five or eighty dollar protractors. It is a great credit to its maker as it certainly is a fine peice of work. It has double opposite verniers, clamp and slow-motion screw, folding, pricking points, and all of the usual elegant paraphernalia of its kind. And I suppose there are people who use such instruments for I frequently see mention of them in catalogues of drawing instruments; but I will here take space to say that a good straight edge, dividers, scale, and table of natural tangents, give far more accurate results, where extreme accuracy is desirable, and these things we can all possess.

Next is the case of Knox and Shan, 716 Chestnut St., Philadelphia. Here is a small case of instruments of the common types but of what now must be regarded as of quite primitive construction. They are quite "Plain." But I have no doubt they are in favor with the by no means small and uninfluential class who are possessed of a strong dislike for "extras" and "toggle-ments." These makers claim to be the oldest in the United States.

I then visited the exhibit of Fauth & Co, of Washington, D. C. This firm succeed Wm. Wurdeman. They seem to very worthily do it too. Whilst they do not exhibit engineering instruments, strictly speaking, still all of the profession are interested, undoubtly, in the very exceptionably high class of work which they do. It is *too* fine for common uses and of little value for rough purposes. But for these makers, or some like them, however, this country could not now command the respect it does for the high degree of reliability and accuracy of its coast and lake survey work. What has therefore such a direct bearing upon our national reputation can be viewed with patience, at least, I think. Here are shown but four instruments. They are of the incomparably fine character of the familiar Wurdeman work. There is a small equatorial telescope upon its pedestal, furnished with very complete appliances indeed. There is with it a complicated micrometer eyepiece with tubes for illuminating the diaphragm, graduated circle attached, making a very complete affair indeed. Besides this there is a set of seven other eyepieces. There is an altitude and azimuth instrument with about a twelve-inch limb. Dr. Hilgard's appreciation of this instrument was so keen that he bought it for the coast survey. It has three microscopic micrometer verniers to the horizontal limb and has two to the vertical. The wyes are of a somewhat peculiar construction, coming out with a curve directly from the center of the instrument above the plates. A complete seven-inch limb transit theodolite, so called, is also shown. There is one feature about it that it would be well if all instrument makers would adopt. That is the three legs to each wye, the two outer ones being curved so that their feet stand well in towards the center of the plate, whilst the middle one is directly under the bearing. The little level exhibited is neat and complicated and fitted for certain purposes no doubt with great care, but not suitable for common rough work. It has a needle, segmental vertical circle, horizontal graduated circle, and a gradientor attached.

J. B. D.

Engineering Field Work.

[Written for Engineering News.]

III.

Two years ago there were more Engineers employed upon the surveys incident to railroads, than on any other class of work, but it is doubtful if any more are now engaged in this kind of work than in other departments of the profession. Still, as the field work in the location and construction of railroads is of so comprehensive a character it will be well to consider it carefully and in detail.

The three classes of surveys, viz: Preliminary, location and construction form as good divisions as can be suggested for this subject, and we will consider them in order.

The object of a Preliminary survey is to ascertain whether it be feasible to build a line of railway between two points upon the surface of the earth, and this information is obtained for certain parties who wish to make money in some way or other by constructing or having such line of railroad constructed. For this purpose the parties employ a more or less competent engineer to make these surveys giving him authority to employ one or more field parties according to the magnitude of the work, and the money they may think they can spend upon it. If only one party is employed it is sometimes under the direction of the chief engineer himslf, but more commonly under an assistant employed by him.

The organization of this field party is usually as follows:

1. The Assistant Engineer in charge of the party.
2. The Transitman whose work is the running of the line and keeping of all notes thereof.
3. The Leveller whose work is taking the levels, drawing the profiles and making the estimates therefrom.
4. The Level roadman, assistant to the Leveler.
5. The head chainman who should also carry the transit rod and get therewith the lines given by the transitman.
6. The hind chainman, who should also number the stakes and keep track of all distances measured.
7. From one to five axemen according to the amount of chopping needed for the work.

The above may be considered as all the men needed for the professional part of the work, and if the country is inhabited will be all that will be employed; if there are only a few inhabitants a team and driver may be advantageous, but if uninhabited and it becomes necessary to take a camp outfit, at least two more men are indispensable—a teamster and a cook, the latter being a very important member of the party.

The duties of the engineer in charge of the party are too many for enumeration here, but he has to see that the greatest amount of work possible is done for the money expended; his business is to get information for the chief engineer and to keep his party running without delay. A word of brotherly advice to him may not come amiss and is meant kindly if it is not necessary.

In selecting your party for a start use judgment and

your knowledge of human nature; don't get two men who have any feud with each other in the same party if it can be helped. Study your men all the time and be frank and free with them; do not talk much with them in working hours, but watch all hands very closely, for the first few days especially. Remember that your men are men, and treat them well, show them that you know how the work should be done, but don't "nag" them all the time; if you have a horse, don't keep them at work till dark and then ride off and leave them to walk three or four miles to supper, but either quit work in decent season or lend your horse to some fellow who is fagged, and walk in with your men; don't hang round in the morning and let your men wait for you, but pick up an ax or rod and start first for the work; get into good training for walking, and if you start for supper last, pass all the men on the road; don't shirk work yourself, and don't let any body else shirk; never ask a man to do any work you would not be willing to do yourself,—we remember "stripping to the buff" and wading a stream four feet deep when the cakes of ice were coming down, because we thought the men hung back and did'nt want to go into the water; don't worry the transitman's wits out of his head by asking him questions; find out what he is doing and recording, but dont crowd him too hard or bluster about him; dont swear habitually before the men if you can help it, you may want to swear at them some times, and if not used to it they will be more apt to obey; don't scold a man when you are angry yourself, if you can help it, but wait and talk to him after supper, when you have cooled down.

In selecting a camp outfit be especially careful to get a good cook, and we advise a good cooking stove of cast iron with enough pipe to draw well—we remember a sheet iron stove which had to be taken down every morning and the soot kicked out of it before a fire could be made to "draw," and we also remember the satisfaction with which the boys kicked the miserable thing to pieces after it had been "returned" at headquarters. We are more particular in this matter not only because we like to be well fed, but because men must be well fed in order to work well—and you must remember that poor food will make bad temper and bad work, and that the interests of your employers demand that you keep your men contented with their job.——So much for the *care* of the men.

Don't let your leveler get too far behind the transit work, and see that he checks his levels and establishes benches at proper intervals. After the work is well started you will be obliged to go ahead and make yourself familiar with the features of the country and select the points where your line must be run. A preliminary line is usually run without curves, and the work of the transit man is much easier than in location surveys and the line work is much more easily carried on than when locating, and this brings us to the work of the transitman. But before leaving this part of the subject let me remind you, that as your work progresses, you will have to come in contact with the property holders and residents of the country, and you should always bear in mind that you represent large interests and can give them by your manner a favorable or unfavorabe impression as you choose.

The transit man has the hardest work of the party to perform; he has to stand with one eye at his instrument as long as the men can set stakes, and then when he is called up, the whole chain and axe force have to be idle till he arrives at the place where they are and has set up and lined his instrument; he is supposed to direct the work in the absence of his superior, to know the topography of the country ahead and run his line to suit the ground—to keep all the men at work and not let them loaf around—to keep all notes and if possible sketch all the topography; to act as chief assistant in every way, to be bookkeeper and cashier of the party; if in camp to purchase supplies and see that things go right generally. The skill of the transit man in the field consists in his realization of the peculiar features of the ground and his judgment in running to them, and to his being able to work under mental pressure. The mere instrumental work in a preliminary survey is easy to do as it consists only in running bearings, noting angles and giving the line to the men at the chain. A few words to the transitman. Carry your instrument yourself,—don't let any of the men take it at night unless you are just ready to drop with fatigue. Your men may very probably offer to carry your instrument, as a common courtesy, or even to make friends with you, but don't accept such favors; among working men, from which class your chainmen and axemen will most probably come, there is but one standard of comparison, and that is strength, and although one of them may be perfectly willing to shoulder your fifteen lb. transit for three or four miles you will not gain his respect by letting him do it for you. If you have not strength make up for it in endurance and quiet pluck, and if you want to grumble don't do it before the men. You and the engineer-in-charge must be in perfect accord, at least in appearance if you want to further the interest of your employers and your own also. In setting up a transit on sideling ground it is generally better to put one leg of the tripod up hill and two down, but you must exercise a little common sense in the matter; try to keep the lower "parallel plate" as level as possible, as by so doing time in "leveling up" will be saved; try to make youself master of your instrument as there is a great range in the value of transitmen, and try to "set up" each time a little quicker than before and also a little better. The acme of setting a transit may be considered reached when one shove on each leg of the tripod brings the "plumb-bob" exactly over the point in the stake, while the instrument is found level "both ways." Try and see how many times you can do this every day, but don't waste time studying how to do it at each "set." It is rather better to keep the plates clamped together at zero, and do all lining of the instrument with the lower clamp and tangent; take bearings on both fore and back sights as you may detect errors in reading angles by so doing, and be careful to record which way angles are turned. It is most convenient to run your transit ahead always and read the same end of the needle if the instrument is in as good adjustment as it should be. The stability of the adjustments differ very widely in different instruments. We have worked with an instrument for three months which never had to be touched, and also with another from the same maker which would not reverse truly for the day, although adjusted every morning; it becomes necessary, therefore, to learn the peculiarities of your instrument, and know, not guess, at its condition at all times. The reversal should be tested each morning before going to work until you are sure of the instrument. Learn which way to get the slack of the tangent screws and to do good work with a poor transit.

The leveller on a preliminary survey may have to work at his best to keep up with the transit party, and as the leveller and rodman have to work completely in unison we will give them our advice together, as to their field work. Of course, in the office, or in camp they are two very different people, the leveller being one of the commissioned officers of the party if we may use a military term, while the rodman is about the grade of a sergeant only. Still there should be very little difference of feeling between them. The leveller keeps all field notes and the rodman should also carry a book and keep the turning point sights and work out all heights of the instrument and elevations of turning points and benches in the field. Readings for turning points and benches may be taken to thousandths but for station heights the nearest tenth only should be read.

Make all the vertical height you can in going up or down hill as you may save a setting thereby. Study the ground as to what is coming ahead and never select turning points or set up the instrument without having fully considered what is to be done next.

Be sure of the adjustments of the instrument and that the rod is held "plumb" (if the cross hairs are right, the man at the instrument can see by the vertical hair if the rod is "plumb" one way, and by gently swinging the rod in the plane of the instrument after setting the target if the target rises above the hair, the rod was not held "plumb;" if the target, on swinging the rod, falls below and just comes up to the hair, the rod has been held vertically). Make your signals with some system, and move the rod according to the signals in amount of motion as well as direction. Speak your numbers distinctly and don't mistake the word seven for eleven, or the reverse.

Levelling can be hurried in open country by employing two rodmen and rods and running them alternately, the employment of a fourth man to keep notes in such case being a great help, although such great haste is not often required or desirable.

Put in benches at least once in 1500 ft. in open country and every 1000 ft. in rough country, as it may save you a good deal of work; select good points for benches and turning points, and always be sure that the instrument may be moved before you move it, and that you can find at least half of the turning points in the days work.

In running "check levels" check up the benches every mile, and if the agreement is within one tenth call the bench right and go on. Try to keep the check levels within two miles of each other, as it may save a good deal of annoyance.

The work of the rest of the party is much the same for location and preliminary surveys and will be described in our next article. The Engineer in charge of the party and the transitman are the ones whose work is increased the most, and their duties will be described again for location surveys. S.

Graphical Statics.

BY ANTONIO FAVARO.

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The Author shows in this paper how the modern science of mathematics is founded upon ancient science. Analysis and geometry have always struggled for the precedence, and although the invention of Descartes, of representing lines and curves by algebraical equations, favored analysis, it is now admitted that geometry gives greater facility for representing problems and their results, in consequence of which it is now used in questions formerly entirely referred to analysis.

The step from applied science to practical application was made by Culman, who based geographical statics on pure geometry, and showed what part it was to play in the science of engineering; and the author, following that system, divides his subject into—1. Geometry of position. 2. Graphical calculus. 3. Graphical statics.

Geometry of position or projective geometry comprises principally the propositions of mathematicians, such as Euclid, Appollonius, Pappus, Desargues, Pascal, etc., remarkable for great penetration and ideas, but who are wanting in the scientific invention of the present day. Modern geometry employs both the synthetic and analytic methods without their disadvantages. The first advance in geometrical science was made by Desargues and Pascal in the sixteenth century; the analytical geometry of Descartes was followed by the differential and integral calculus and mechanics. At the beginning of this century Carnot proposed a new method of studying the geometry of the ancients, and published "Correlation des Figures de Geometrie," "Geometrie de Position," and "Theorie des Transversales."

Poncelot followed with treatises on the projective property of figures and the theorem of reciprocal poles, which originated the schools of Steiner, Chasles and Staudt. About the same time Chasles in his works on ancient and modern geometry treated of the difference between pure and applied geometry. Steiner bases his system on the metrical and transformable property of figures; Chasles on the anharmonic ratio, homographic division and on involution, and does not make use of the law of continuity; whilst Staudt excludes the metrical property of figures, and treats geometry independently of measure, showing in its full force the law of duality and reciprocity by which all plane geometry is ruled.

The necessity of combining graphic operations with numerical calculations in designing has forced engineers to seek a uniform method, and as the numerical system has been found impracticable, it is now sought to apply the graphical method. Mœbius having introduced it in his "Barycentrische Calcul," was followed by Gauss, Bellavitis and Grassmann, who explain the geometrical system of calculations. In France the remarkable work of Cousinery, "Calcul par le Trait," is supposed to have been the basis of Culman's "Graphische Statik." In the graphical calculus all figures of whatever form are represented by lines, and through them addition, subtraction, division, raising to powers and taking out roots are carried out. The calculations of sections of earthworks for railways and roads are solved by the same method, and it is found to be more accurate than the approximate method of the mean of two extremes areas. It has been used on the Bavarian railways and more recently in Würtemberg, and it has also been applied by Muller and Rankine.

The graphical study of mathematics presents clearly to the eye mechanical problems which, by the analytical method, are difficult to grasp, and Poncelot has shown what use even the industrial mechanic might make of such a study. Cousinery also uses this system in the solution of problems, in his "Calcul par le Trait."

Culman defines it as the science which shows how the conditions of equlibrium of given forces, representable by means of algebraic expressions, can be found by constructive or graphical methods. With reference to the graphical calculus, he assumes for the statics the two following propositions relative to the composition of several forces applied to a point—the resulant of several forces applied to a point passes through that point, and the forces are composed by lines, since they are capable of being thus represented. This being allowed, he shows the way in which all theoretical statics and the practical application of them are resolved in a uniform and simple way by two figures—the polygon of forces which gives the intensity of the resultant of the forces, and the funicular polygon which determines its position.

The author then describes Cremona's application of graphical statics to reciprocal figures, and Culman's exposition of the use of the graphical method in determining statical moments and moments of inertia. It is shown that though the funicular polygon is the simplest method of finding the resultant of a number of forces, the theory of the Giratory of Bellavitis, or of infinitely small forces placed at an infinite distance, as proposed by Culman, offers the only means by which the composition of forces in space becomes possible.

The engineer, however, seldom has to treat forces in space, but generally those situated in a plane, and particularly parallel forces, for which he may adopt the usual method of the polygon of forces and the funicular polygon, by which the conditions of equilibrium of a frame or of a suspension bridge may be found. The graphical method shows clearly the relation between the moments of flexure and the breaking weight, it simplifies the long, troublesome and unreliable calculations for finding the most favorable position of a train of locomotives on bridges of various dimensions, and is of great help in solving problems relating to irregular figures which are so dificult to treat by the ordinary system. It also shows the ease with which moments of a superior degree of the same force may be obtained from simple statical moments of parallel forces in a plane, from which follows the known theorems relative to the ellipsoid of inertia and that of the central ellipsoid.

In treating of frames Culman explains the equilibrium of external and internal forces applied to its transverse section, and applies it to the internal forces working in a rail, and their distribution in figures of the form of a crane; and he has also rendered great service to the engineer by graphically solving the strains on bridges, and more especially of continuous girders, in which the moments of inertia are continually varying; and lastly, he treats of the equilibrium of retaining walls and stability of earthwork. J. K. R.

Cable Towing on the Erie Canal.

The Lockport (N. Y.) *Times* recalls the fact that two years ago a company laid in the canal, between that place and Buffalo, a small wire cable, which, attached to a peculiarly constructed power, upon a tugboat built for that purpose, was used as a means of towing boats. Last season, owing to embarrassments which seem inseparable from new undertakings, little or no success attended the enterprise. This season, however, the results have been more satisfactory. A portion of the cable was taken up and relaid toward the east, and it has been in operation from the Guard Lock west to Middleport east, a distance of about twenty miles, for the past two months. The results have been so satisfactory as to induce its projectors, and many others, to believe that they have solved the problem of cheap and rapid canal transportation. The depressed state of canal business, and the fact that nearly all boats carry their own teams, has operated against its power, but notwithstanding its greater speed has caused many boatmen to avail themselves of its use, especially in the narrow channel and rapid current above the locks, where horse-propelled boats have a difficulty in making only two miles an hour. The cable boat will take a tow of five or six boats and propel them easily against this current at the rate of four or five miles an hour. It does this without creating an unusual swell in the canal and with an astonishingly small consumption of coal. We have not the data from which to state accurately the amount of its towing powers or its costs.

Engines for Inclined Railways.

The Bridgeport (Conn.) *Standard* of July 15 says: "Messrs. Copeland & Bacon, of this city, have constructed, under the supervision of Mr. Henry C. Walters and from his designs, a locomotive for use on inclined railroads, and we yesterday had the pleasure of observing its workings on the inclined track, built for the purpose of testing its capacity, near the water, just above the Congress street bridge. The engine stands upon an open platform and is worked by means of a strong wire rope which runs from one end of the track to the other, making several turns around two large drums on the engine, one above the other, the upper drum being connected with the steam power by means of a huge cog-wheel. The track on which the locomotive is now being tested rises one foot in ten, and the machine will do even better than that. Six of these locomotives are to be built by Messrs. Copeland & Bacon for use on a couple of mountain roads—one near Salt Lake and the other near San Francisco. They are four miles long and very much curved and do a freight and passenger business, connecting two other railroads with each other. The locomotive works finely, going up hill or down with equal facility, and can be stopped anywhere on the steep plane without difficulty. When in actual use these engines will draw the cars up the hill and they will run down without assistance."

The East River Bridge.

The New York *Post* says that the carpenters are now engaged in constructing the flooring for the foot-bridge to be thrown across the East river, and the cables for its support, which have arrived from Trenton, N. J., will probably be put in position early next week. The flooring is a heavy oak lattice-work, in sections twelve feet long and four feet wide.

The manner of placing the cables will be as follows: When all the preliminaries are completed the end of the first or small cable will be fastened to a large drum on the top of the Brooklyn anchorage, carried thence over the tower and put on a tug-boat which will pull it across the river. It will next be secured to the New York anchorage, and then taken back to be united with the other end on the Brooklyn side. There will then be a continuous line of iron rope from shore to shore, and this line will be used for the easy conveyance of the large 2⅝-inch steel cables on which the foot-bridge is to rest. The clamps to be used are made of brass, and will bear a strain of one hundred and seventy-five tons. They are five feet long and proportionately thick.

The work of making the main cables for the principal bridge will take at least two years longer. They will be stretched across the river by the aid of the cables already in position. When 330 wires have been laid the process of clamping will begin, the clamps being six inches apart. Then 330 more will be laid and clamped. When the whole number of 6,270 wires have been thus laid the temporary clamps will be removed and the permanent ones, binding all the wires, applied. The cables, therefore, will be composed not of twisted but of parallel wires. At each side of the towers there will be a large iron saddle, and in the middle of the towers two saddles, each one weighing fourteen tons.

The Boston city committee on bridges opened the proposals for building two iron sliding draws in the Dover street bridge yesterday. Eight bids had been entered. The highest was $36,869, and the lowest was that of Thomas Leighton of Rochester, N. Y., $14,800. Mr. Leighton was awarded the contract.

A contract has been completed between the Little Rock & Hot Springs Railway Co. and W. P. Hanchett, for building a single track road from Little Rock to Hot Springs, Ark. The work will be commenced on Oct. 1, 1876, and is to be completed within one year. The length will be sixty miles. The cost of grading, laying the iron and completing the road in readiness for the cars will be about $500,000.

Railway News.

Fort Worth, Texas, is now connected by rail with the rest of the world.

The Rochester and State Line road (N. Y.) will be completed to Salamanca by January next.

The Little Rock & Fort Smith Railway is now completed to Cherokee, on the Arkansas River, opposite Fort Smith.

The people along the line of the proposed Chicago & Tomah Railway are rejoiced at the prospect that the line will be built.

It is proposed to build a railroad from Fort Dodge, Iowa, to Fort Ridgeley, Minn., if a sufficient amount of local aid be furnished.

Over 32,000 tons of American steel rails have been received in San Francisco from New York during the past year for the Southern Pacific Railroad.

The Boston and Albany are building a new iron bridge over the Charles river at Riverside. The bridge will have stone abutments and be wide enough for four tracks.

The gauge of the Galveston, Houston & Henderson railway has been changed from broad to narrow, the work being accomplished on the entire line, 170 miles in one day.

Fifty-six steamers ply on the waters of Oregon. In tonnage they range from 8 tons to 673. All but two were built on the Pacific coast—the larger part of them quite recently.

The report that the Pullman cars running on the Midland road, England, are not paying is untrue, the line paying as well as any other line on which the cars are run, either at home or abroad.

A new line called the Chicago, Florida & West Indies Railway, has been organized. It is to run from Dupont, Georgia to Charlotte Harbor, Florida, branches connecting with Tampa, on Tampa Bay, and Sanford on Lake Monroe.

Work on the Manchester & Keene (N. H.) Railway is progressing rapidly between Greenfield and Keene. More than one thousand men are at work already, with an increasing force daily, and it is expected that the cars will run as far as Bennington before the snow flies.

Engineer H. F. Keith has reached South Egremont on his way from Copake in his work of survey for the proposed New Boston & Poughkeepsie Railway. It is about 42 miles from the state line of Mass. to Poughkeepsie. No unexpected obstacles have yet been encountered.

A survey for a narrow-gauge railway will soon be made on the west side of the Connecticut, south from Holyoke as far as Windsor Locks, and perhaps as far as New Haven. The matter has been for some time under consideration by Holyoke capitalists.

Work has been commenced between Dixon and Rockford on the Rock River Valley extension of the Rockford, Rock Island & St. Louis Railway. It is intended to ultimately extend the line from Rockford northward to Beloit or Rockton, to connect with the Wisconsin roads.

A mortgage for $32,000,000; $30,000,000 to bear seven per cent. interest and $2,000,000 six per cent., given by the New York Central & Hudson River Railway Company to Cornelius Vanderbilt, Jr., and Wm. H. Vanderbilt, was recorded in the county clerk's office at Albany, N. Y., on the 7th inst.

Travellers going through to Boston by the Pennsylvania Central have their palace cars shoved aboard a steamer at Jersey City which takes them by the Battery and up East and Harlem Rivers to the New York and New Haven crossing, where they are again shoved on the track for Boston and other eastern points. The transfer occupies but little over an hour and and avoids the tedious soul-stirring transfer through New York City.

Mr. Bancroft, the Receiver of the Chicago & Lake Huron Railroad, states that all obstacles to the completion of that line by filling the gap be ween Flint and Lansing have been removed and that the work will be pressed forward as fast as money and men can do it. The road will be in running order from Port Huron to Chicago by Dec. 1. The money to complete the road is furnished by the Grand Trunk Railway Company, which is said to have effected a lease of the Chicago & Lake Huron road. This move, will give the Grand Trunk the much-needed outlet to Chicago.

Contractors' Intelligence.

The Baltimore Bridge Company has the contract for five bridges at $450,000.

The Nashua, N, H, Iron and Steel Works Company have started up, having received large orders.

Three car-loads of car-wheels, from the works of Barnum, Richardson & Co., recently went down the Housatonic road to New York, whence they are to be shipped to South America.

The new bridge of the Delaware Lackawana & Western across the Hackensack river, N. J., will soon be completed at a cost of $160,000. The bridge is of four iron spans on stone piers.

Work on the New Orleans Pacific road is steadily progressing, Contractor James having nearly 1,000 men at work. He expects to have the 65 miles from Alexandria, La., to Provencal graded by November, his object being to get out of the low country before the winter rains set in. The country from Alexandria to Provencal is perfectly flat, but the road has to be raised several feet above the general level to secure it from the floods.

The Leighton Bridge & Iron Works of Rochester, N. Y., have just completed the last of six bridges for the Boston & Albany Railway. They have recently taken the following contracts: Highway bridge over Connecticut river at Springfield, Mass., $71,500; Viaduct over Chicago & Northwestern Ry. tracks at Milwaukee Avenue, Chicago, $34,690; bridge over Esopus creek at Kingston, N. Y., for Ulster & Delaware Ry., 211 ft. span, $11,500; bridge over Hudson river at Fort Edward, N. Y., for D. & H. Canal Co., 600 ft. long, $20,000; Neponset river bridge for city of Boston, $10,800, and Dover street draw-bridge for city of Boston, $14,800.

The work of dredging the Cove basin in Providence, R. I., will be begun about the first of September. The contractor, Mr. John B. Wood of Brooklyn, N. Y., is going to build two scows, 50 feet long and 13½ ft. wide, upon the Cove lands, just above the Gaspee-street bridge, and will launch them in the Woonasquatucket River. These will be floated through the bridge into the Cove, and joined together with a foot's space between them. Upon these scows will be placed the dredging machine, which is of pecular construction, being invented and patented by Mr. Wood. Three other scows will be then built, 65 feet long, 16 feet wide and 4 feet deep each; on these a railroad track will be placed, and on the track five six-yard dumping cars will be run. The wall of the Cove, at a point about 150 feet from the above-named bridge, will be taken down for a distance of forty or fifty feet. Here an inclined plane, or more exactly a floating wharf, which will rise and fall with the tide, will be constructed. The railroad track will be continued from the scows over this wharf and thence to the Cove lands or anywhere else that is decided upon. By means of this apparatus the 270,000 cubic yards of mud will be taken out. The cove will be dredged for a depth of three feet below low-water mark, and as the mud is many feet above that mark in some places, the average dredging will be five feet.

Foreign Intelligence.

The French metric system of weights and measures will soon be introduced into Russia.

There are ten bridges across the Thames in London proper, and an eleventh is to be built just below the Tower.

The Settle and Carlisle Railway (Great Britain) is seventy-two miles long and has cost £50,000 per mile, or £3,600,000. It has steel rails throughout of 82lbs. per yard.

A train called "the Flying Scotchman," has been put on the road between London and Edinburgh. It accomplishes the distance, 397 miles, in 8.48 m., or at the rate of 45.1 miles per hour.

Recent advices state that the late earthquake has affected the basin of the Danube to a very considerable extent. Rents are visible in many houses in Vienna. The river Danube receded from the right bank and passed in a great wave upon the other shore.

The German government has recently finished the laying of the experimental subterranean telegraph cable between Halle and Berlin. It is pronounced highly successful in operation, although the task of laying it was a tedious one,—a squad of three hundred men, with twelve horses and wagons, putting down about two miles a day. The cable used consists of seven strands.

A contract between Mr. Gogorza and the Colombian government has been made for the survey, and, if practicable, the building, of the Darien Interoceanic Canal. The surveyors are to be on hand within six months after May 28th. They are to be of several nationalities. The result of the surveys is to be submitted to the Colombian government within six months after the commencement of the surveys.

An English paper says: "The introduction of large ships of war has rendered the old-fashioned hawsers compartively useless. For this reason some new experiments have been made with steel hawsers at Devonport under the authority of the British government. The steel hawser used was eight inches in circumference against a hemp one that was twenty-five in circumference. The report as to handiness in working was entirely in favor of the steel wire hawser. Another great consideration is that 120 fathoms of 24-inch hemp cable weighs seven tons sixteen cwt., while the same number of fathoms of eight-inch wire cable, which is equal to, if it does not exceed, the strength of the other, weighs only two and one-half tons. The wire rope which was tested is equal in strength to a two and one-half inch chain, the weight of which would be sixteen tons."

Grand Trunk and Great Western Railways.

The amalgation of the interests of the Grand Trunk and Great Western of Canada, has been accomplished in accordance with the term contained in the memoranda below. Mr. Seeman, president of the Northwestern has been appointed umpire in all disputed points, and his decision is to be final. The agreement is to go into effect as soon as the present railway war is settled, both roads to use their utmost efforts to accomplish that end at an early day.

The presidents and boards of the Grand Trunk and Great Western Railway companies of Canada have agreed that the competitive traffic, between those companies shall be divided, on a plan similar to that established for many years, under the "Gladstone award," in this country.

The managers are therefore instructed to meet without delay, and, taking in turn each town or district served by the two companies, are to arrange the percentage for the division of the traffic, agreeing the rates and fares.

The managers will remember that a percentage for working expenses will be allowed to the company carrying more than the agreed proportion.

The presidents and boards are very unwilling in the first instance to appoint a third party to decide between the managers when they differ; and they prefer to instruct the managers to make all possible concessions, bearing in mind the want of such an arrangement as is now contemplated is likely to be far more disadvantge ous than any slight loss in the percentage claimed.

They therefore desire that, by compromise and mutual concession, these agreements may be brought about, without further instructions from this side, or the introduction of an umpire.

The agreements are to take effect from the earliest practicable date, if possible the 1st of July, and to be for ten years.

As each schedule is settled it must be reported to London, to be confirmed and sealed by the two boards.

The presidents and boards further agree that they will recommend their respective shareholders, at the next half-yearly meeting, to confirm this agreement; as provided by the statutes of the Dominion parliament.

RICHARD POTTER,
President Grand Trunk Railway of Canada.
HUGH C. E. CHILDERS,
President Great Western Railway of Canada.
London, July 8, 1875.

Heating a Fifty-Six Ton Trunnion Coil at Woolwich Arsenal.

It was brought out of a furnace whose mouth, when it gaped, was like the opened west-end of a cathedral. Nebuchadnezzar's burning, fiery furnace must have been nothing to it. The coil had been in fifty hours, and had been heated at a cost of somewhat over five-and-twenty tons of coal. Aided by two cranes, each capable of bearing 100 tons, and a pair of tongs weighing, I should think, six tons at least; an army of firemen, who to such work seemed dwarfed to Lilliputians, swung the coil on to a 750-ton hammer block that had in turn for its foundation one hundred 50 feet piles 14 inches square. Here the coil stood erect like the peak of the Jungfrau transmuted into gold in the setting sun, as, like myself, many, I trust, of my readers have seen it from their hotel at Interlachen. Cyclops and his men were mighty fellows, but all their hammers put together would seem but a toy compared with that hammer which came thudding down upon this immense coil. The hammer-head weighed forty tons. With steam behind it it has a force equal to 200-foot tons. Foot tons, I need hardly explain, means tons possessing the force given to them by a one-foot fall. The hammer stood there at an elevation of some fifty-six feet. Most delicately, like Poe's raven, it came tap, tap, tapping; for these blows, mighty though they were, seemed but taps upon the brow of this iron Jungfrau, so firm and erect did the coil stand beneath them; nevertheless, you could see the effect. The glowing interstices in the twist gradually lessened; but even after the British Cyclops had expended all the power he chose to put forth the outlines proclaimed the mass to be a coil still. The coil had not only to be compacted into a tube with comparatively solid sides, but it had to be kept perfectly true in its center. From the opposite side of the hammer was now, therefore, reared by the aid of the crane and another pair of gigantic tongs, a steel mandrel which the delicate attention of our friend Cyclops with his tap, tap, tapping soon forced into the center of the coil. His ribs thus blown out by the indigestible mass which he had been compelled to swallow, the 56-ton coil now heavier by many a ton by reason of his meal, must have his sides well belabored. For this purpose, the surfeited coil is again clutched by the huge tongs and sent sprawling upon the block. Here the Cyclops began again thumping away at the poor fellow as he lay prostrate; this time helping very considerably to close up his ribs.—*American Manufacturer.*

The Mississippi.

We extract the following account of Capt. Eads' proposition together with his statements in regard to the condition of South Pass, from the Philadelphia *Press*, omitting, however, such portions of it as are covered by Mr. Bayley's letter and the extract from the Boston *Advertiser*:

Captain J. B. Eads, of St. Louis, was recently invited by the Committee on Commerce of the House to address them on the subject of the best method of improving the navigation of the great river from Cairo to New Orleans. Captain Eads assured the committee of the entire practicability of protecting the alluvial lands of the Mississippi, comprising nearly 40,000 square miles of the richest country in the world, from overflow, by the proper correction of the river channel, by which the flood-line would be reduced to the least degree, and the use of levees rendered absolutely unnecessay; and further, a channel of twenty feet secured from Cairo to New Orleans at all seasons of the year. The flood-line of the river at Cairo, Captain Eads said, was nearly fifty-two feet above the extreme low water, and it is only necessary to lower this flood-line ten or eleven feet to prevent any overflow at Cairo or any other point below that city or above the mouth of the Red river. Captain Eads assured the committee that the system which he proposed was not original, but that it had been applied with signal success for the reclamation of the alluvial lands of the Rhine and in Holland, and that it had accomplished a great improvement in the navigable channel of the river, at the same time rendering the use of levees for the protection of the bordering lands entirely unnecessary.

* * * * * *

It has been inferred that because the large sailing vessels and steamships are still using the Southwest Pass, notwithstanding the fact of the work on the other, that the depth of water in the South Pass is not so much, and that the success of the jetties is not an assured fact. In explanation of this it is not generally known to the public that the pilots all live at the mouth of the Southwest Pass, which is now kept open by the constant operations of the United States dredge boats. When these pilots take a vessel out to sea from the jetties, they have from 22 to 23 miles to return to their homes in Pilottown. If they take a vessel in by the jetties they cannot leave her until she crosses the shoal

at the head of the pass, this shoal being 12 miles above the jetties and 15 miles above Pilottown. It is evident, therefore, that so long as sufficient depth is maintained at the mouth of the Southwest Pass, the pilots will not be in favor of taking vessels out or in by way of the jetties. But as two hours' time from New Orleans to Philadelphia and other seaboard ports is saved by passage through the jetties, the Cromwell and the Morgan steamship companies peremptorily ordered their pilots to take their vessels through the South Pass. This they continued to do until about a month ago, when they temporarily discontinued for the following reasons: A part of Captain Eads' plans for the improvement of the South Pass contemplated the closing of Grand Bayou, an outlet half-way down the pass, which discharges nearly one-quarter of the water entering the head of the pass. It was foreseen that the closure of this bayou would largely increase the volume of water through the jetties, and would temporarily retard the flow into the pass at its head, from which cause the loss of depth would ensue above the shoal at the head of the pass. A part of the system of works, however, contemplated a reduction of the width of the channel at the head of the pass. An island is situated at the head of the pass, and divides the flow of water into it. It was contemplated to close one of the outlets by the side of this island, and thus concentrate the flow of water into the remaining one, and this would have been accomplished simultaneously with the closure of the Grand Bayou. If this programme had been carried out no shoaling would have occurred at the head of the pass. But, owing to unforeseen difficulties, the closure of this outlet was not accomplished until six weeks after the bayou had been closed, and the result was that the water shoaled at the head of the pass until only fifteen feet remained in the channel there. The eastern outlet into the pass has been closed within the last ten days or two weeks, and in that time the water has deepened over the shoal to more than its original depth, and this deepening at last advices, is still increasing. When the depth had lessened to ten or fifteen feet the Morgan and Cromwell lines of steamships were compelled to temporarily abandon the use of the jetties.

The merchants of New Orleans, knowing the fact that the sea entry into the Mississippi was much superior by the jetties than by the Southwest Pass bar, petitioned the Government some months ago to order the United States dredge boats removed from the Southwest Pass to the head of the South Pass to deepen the shoal there, this shoal not being exposed to the waves of the sea, being sheltered by the land. The petitioners set forth that whatever was accomplished by the boats at the South Pass would be permanent, whereas, on the other bar, the operations were several miles out at sea, and every storm or gale destroyed the work previously performed. The matter was referred to a committee of engineers. They declared that it was the duty of Mr. Eads to deepen this shoal, and they refused to recommend the dredge boats upon it. Works have, however, been designed and are under construction for the deepening of this shoal, and there is no doubt whatever that within a few months a depth of twenty feet will be secured upon it."

Jetties at the South Pass Mouth of the Mississippi River.

The following letter in regard to the Jetty Improvement was published in the New Orleans *Times* and is dated July 25. It was written by G. W. R. Bayley, Resident Engineer in charge of the jetty works, and is of interest, as giving the jetty advocates' side of the question.

"In January last the channel depth, for more than half a mile in length, across the bar of South Pass, was about eight feet at ordinary high water. On the bar of Southwest Pass, which discharges about four times the quantity of water flowing through South Pass, the channel depth at ordinary high water, aided by persistent dredging, was and now is generally about eight and a half feet, sometimes a little more and sometimes less. Dredging there seems to add but a few inches (possibly at times twelve to eighteen inches) to the natural depth, and in a channel way varying from 60 to 80 feet in width of the available depth obtained.

During very high tides, when the range is as much as three feet, depths of 18¾ to 19 feet, and once 19½ feet, have been reported at Southwest Pass bar, the bottom usually being hard when dredging is in progress.

About one month ago, before the closure of Grand Bayou, which diverted about twenty-three per cent. of the water of South Pass, a least channel depth of 19 ft. had been secured by the jetties across the outer crest of the bar of South Pass, but the close of Grand Bayou, by increasing the jettied channel scour for a time, resulted, temporarily, in a slight decrease of this depth to sea across the outer shoal.

Since then the depth has increased again and is now, once more, 19 feet at high tide, on the outer bar crest, which is but a short ship's length in extent. A wide and direct channel, everywhere more than 20 feet, and in places 25 to 30 feet deep, has been scoured out to the outer jetty ends, and, quite recently, the distance from 20 feet inside to 20 feet outside was less than 100 feet, with a least depth on this short space of 19 feet.

The results, therefore, of jettying the South Pass bar channel have been to deepen it nearly, for its least depth, two and a half times, or from 8 to 19 feet, and the provisional works alone, unaided by dredging operations, have accomplished this much since January. This, it would seem, should be sufficient to demonstrate, to every unprejudiced mind, the correctness of the principles upon which the jettying of the river's mouth are based. Had Capt. Eads been permitted to jetty the mouth of Southwest Pass, as he so earnestly desired to do, a corresponding increase of the natural depth there, 15 feet at low water, would have resulted in a navigable depth of more than thirty feet.

Heretofore, two forces have been (and yet continue in) operation at the mouth of South Pass; one that of the greatly increased river current, due to concentration, which has been excavating a new and deep channel through the old bar to sea and removing seaward an immense mass of sand and mud, equal to more than 3,000,000 cubic yards, in addition to the sediment ordinarily contained in the river water, and the other that of the ocean currents which sweep athwart the outer bar crest and bear away to the westward the earthy materials so carried out. That these currents exist coastwise, although often denied, is an uncontrollable fact and well assertained. A casual glance at the map of the Mississippi and Louisiana coast line will be sufficient to show that it has always existed, for how else account for the deep indentation of the coast line east of the river's mouth and the great advance westward, all the way towards Texas. The enormous bulk of the deposits borne to sea by the river have been for ages swept to the west, and that is why the river itself has been forced eastward. The entire coast line of Louisiana is formed by Mississippi river sand, washed up by the waves of the gulf, and this coast is lined with drift timber which floated out to sea through the mouths of the passes.

While the jettied channel excavating process is going on the quantity of earthy materials borne out slightly exceeds the proportion which the coast currents can carry away, and therefore, until the jettied channel has acquired its normal section this *excess* is dropped in the edge of deep water and constitutes the only interruption between deep water inside and outside; for the deep inside channel extends to it. The nearer the channel within approaches to its needed dimensions the less is the excess, and the deeper the outlet channel *over* this abnormal deposit becomes, and when the inner channel has become what it is, as to section, where the natural banks confine the flow, then this outer and temporary sand ridge will entirely disappear under the operation of the ceaseless action of the coastwise currents and sea waves just beyond the jetty ends.

This process may be compared to that of two gangs of shovelers; one casting sand from the hillside to its base, and the other loading it into carts and removing the material thrown down to them. So long as the sand and earth is thrown out and down faster than it is removed the pile below will accumulate, and the increase will equal the difference in work done; when it becomes less the pile diminishes, and when the supply ceases the pile below will speedily disappear.

So, when the jettied channel had nearly acquired its needed dimensions, before the closing of Grand Bayou, and the discharge diminished, the depth on the outer sand pile steadily increased, until it was 19 feet; soon it would have been twenty feet and over. Then Grand Bayou was closed, and the flow and current between the jetties was thereby largely increased; the excavating force was strengthened, the sand pile outside increased and grew higher and the depth of water over it for the time grew less. But, already the renewal force has decreased and the pile is being reduced once more. Again we have 19 feet depth over it and, this time, the final depth will be more than before, because the increased quantity of water will need a larger channel outlet section.

The forces of nature may develop results more slowly than our impatience would have them realized, but the end is sure and we have but to wait. Judging by the results so far accomplished a deep channel through South Pass and to sea from it must soon be obtained. At the Sulina mouth of the Danube twenty and a half feet can be carried into the Sulina branch, from the Black Sea, (where from seven to nine feet existed before,) but not more than from fifteen to seventeen feet through it into the Danube itself. Therefore cargoes are lightered to large vessels lying at Sulina, and the same thing might be done at Port Eads, inside of South Pass near its mouth, or near its head, just below the head of the Passes.

This however, although really all that the concession of Captain Eads requires, does not satisfy him nor does it meet the demand of the commerce of New Orleans. He wants and it needs as deep a channel into South Pass as must soon be obtained to sea through and from said branch of the main river.

In the main river, *above* the common heads of Southwest, South and aL'Outre passes, where it is over 8000 feet wide—or more than three times its average width between the Forts and New Orleans—there exists, and always has existed, a "middle ground" shoal. In 1838, according to the report of Assistant Engineer (now General) G. G. Mead to Captain Talcott, of the U. S. Engineers, 48 feet could be carried over this shoal into Southwest Pass and 19 feet into South Pass. Then the former received only 0.34 per cent. and the latter 0.08 per cent. of the main river, while now they receive much more, or about 0.43 and 0.12 per cent. respectively. Nevertheless, now, as the result of the shoaling up of the "middle-ground," caused by the "jump" and "Cubitt's gap" outlets just above the one made in 1840 and the other in 1862—not more than 27 feet at mean low water could be carried into Southwest pass in 1875, and but 14 feet into South Pass. The largest of these outlets, "Cubitt's gap," 2700 feet wide, was made by a United States naval officer at the time of the siege of the forts by Commodore Farragut.

Now, to get the same depth from the main river across or around this "middle-ground" in the river above the head of the passes into, as exists in South Pass, and as is nearly secured from it, it is necessary to jetty a channel across it midway, or one which will flank it from either the east or west side. There is a difference of opinion as to which method is best, but concentration by jetties is required here as well as at the mouth of the pass, and for the same reason, and the results should be the same. Before the recent decline of the Mississippi river—the range of rise and fall at the head of the passes being about three feet—there was a little more depth over this "middle-ground" than is found there now. Then, about 17 feet could be carried over it, now about 16 feet; the difference being about the fall of the river. The steamer Morgan City was grounded entirely to one side of the "middle-ground" channel through mismanagement and unnecessarily.

Captain Eads not being disposed to confine himself to the improvement of South Pass itself alone, and desiring to obtain the same depth into the pass as through and from it, has commenced and avows his determination to prosecute the construction of the works required to secure the needed deep inlet. Had the improvement of Southwest Pass been accorded to him, as he so earnestly desired, no jettying of its head would have been needed, for thirty feet depth can now be carried into it at the ordinary high stage of the river.

The situation then, at present, is, that as good if not a better channel to sea exists through and to sea from South Pass, than is to be found at the mouth of Southwest Pass, with the near certainty of a much better one (which may be utilized by lighterage over the "middle-ground" shoal, as suggested) and that the works needed to secure a like deep navigable inlet channel for through transit to and from New Orleans are in process of construction and well advanced."

RAILROADS IN ILLINOIS.

From the Report of the Railroad and Warehouse Commissioners for 1875, it appears that on the 30th of June, 1875, there was in actual operation in this state 7,109 miles of railroad, owned or operated by about 49 companies. About 3830 miles of this (being considerably more than half the whole railroad mileage in the state,) were owned or operated by the following companies: C. B. & Q., C. R. I. & P., Ill. Central, C. & N. W., C. & Alton, Ohio & Miss., Vandalia, and Alton & Terre Haute Roads.

About 22 other companies, owning or operating at least 2,500 miles of road, are either actually in the hands of receivers, or have failed to pay interest on their bonded debt or incurred a floating debt, and are at the mercy of their creditors and liable to be placed in the hands of receivers at any time.

It will therefore be seen that with the exception of the roads above specifically enumerated, nearly the whole of the remaining railroad interest in this state is vested in the hands of receivers.

All the railroads named are understood to pay interest on their bonded debt, while but four of them are able to make any returns to their stockholders.

With so many of these bankrupt roads intersecting them, it is a wonder that they have done so well. It has become a matter of notoriety that many of these bankrupt roads are doing business at less than cost, and do not even pay their employees. The idea of paying interest on bonded debt never seems to occur to the receiver; as a rule, the aim seems to be to do as large a business as can by any means be obtained, and to do it at any price, no matter whether remunerative or not, and the result generally is a continued accumulation of liabilities against the road.

Owing to the large number of persons in whom the interests in these bankrupt roads are vested, it is difficult to procure unity of action on which to found a reorganization of these companies on such a basis as their condition, might show to be practicable. In cases of mercantile failure, creditors are always willing (save in case of dishonest dealings) to accept such a compensation as they find the debtor's property will pay. The creditors do not however allow the debtor to remain in charge of the property for one, two or even three years and then take the value of the property in settlement. But this is practically what the creditors of railroads have to submit to. They have to take it after it has been in the hands of a receiver for a long time, burdened with the accumulation of interest, and with the road generally in a condition that requires the outlay of a large sum of money to put it in fair working condition.

In the case of most of these bankrupt roads, there is generally a contest between the parties before the court as to the appointment of the receiver, which usually results in the selection of an outside man. He seldom has any interest in the property. Many receivers are no doubt gentlemen of probity and honor, who attend faithfully to the interests committed to their care, but there are also many, whose only object seems to be the making as much out of the property for their private individual interest as is possible. The receiver is under obligation to make stated reports to the court, and the court generally appoints a special master (who is a lawyer) to examine these reports, and upon his approval the court passes them. The court is using the only machinery known to its practice, but it is idle to suppose that such an examination of accounts is of any value. The master has before him a report of receipts and disbursements supported by vouchers. If he finds these agree there is an end of the matter, so far as he is concerned; if these accounts however were laid before one or two practical railroad men they could examine them intelligently with a knowledge of what was required to run the road, and this would be a real check on the receiver, and not a mere form.

The matter of receivers' remuneration is also worthy of attention. It is well known that the late receiver of a small road is now claiming before court to be paid 2½ per cent. on all receipts and 2½ per cent. on all disbursements. This amounts in the case in question to $15,000 for one year. Other receivers supported this charge before the court, contending that it was but a reasonable remuneration. This question is so monstrous that it is difficult to believe any court will uphold it. Small wonder that receivers of bankrupt roads want to increase their nominal earnings, no matter at what cost the work is done!

The system of working railroads through the intervention of courts is one liable to result in gross wrong. The judges of the courts have no special knowedge to fit them for such work. An illustration of this is shown when a receiver applies to the court for leave to incur extraordinary expenditures. The receiver presents his application to the court and his counsel appears to support it. Evidence is only put in on one side, there being no other side to the question, and the judge has to deal with the matter on this one-sided evidence. There can be no doubt that in many cases orders are made which would never be made if the matter were differently presented to the court. The result is that we have several cases of roads in this state, where the whole earnings are alleged to have gone into the road without regard to the rights of creditors.

The moral of this is that it is incumbent on the creditors, particularly the bondholders of bankrupt railroads, to combine at the earliest possible moment, after a road is placed in court, in order to re-organize its affairs, and take it out of court and place it in the hands of parties who will truly represent their interest and in whom they have confidence. And until such time arrives the bondholders should appoint a committee to watch the operations of the receiver, and if necessary, apply to the court for a formal recognition of such a committee, and endeavor to get such an order as would require the receiver to act with and under the advice of the committee.

SOUTH FROM NORFOLK BY WATER.

Survey of a Line to Connect the Cape Fear and Neuse Rivers.

This report by S. T. Abert, U. S. Engineer, dated Feb, 21, 1876, and just issued from the Printing Bureau, contains much that is of interest in a purely scientific point of view, as well as for the surveys in question.

The first part is devoted to a discussion of the forces which have produced the sand barriers along the Carolina coast. Of these the writer recognizes four as chiefly concerned, viz., the Gulf Stream from the S. & S. W., the Arctic current from N. & N. E. which often reaches as far as Florida, the tidal wave which strikes the coast nearly at right angles, and the great mass of fresh water pushing out from the interior. Under these forces modified by the winds, the great barriers of sand, which extend out to the 100 fathom curve, are built up and maintained. The discussion of the coast configuration is interesting, especially of the three arcs which the sand cordon strikes from Cape Hatteras to Cape Lookout, from Cape Lookout to Cape Fear, and from Cape Fear to Winyah Bay. The material of these sand barriers was originally derived by degradation from the country back of the coast and has been thrown up where the conflicting forces were in equilibrium. Along the coast south from Winyah Bay to Florida, he recognizes a greater absence of sand, and the presence of clayed strata which are easily cut by the tides, resulting in a coast deeply indented with narrow and deep inlets, and studded with islands.

Many changes have taken place in this sand cordon by which inlets formerly open have been closed or are closing under the action of currents and winds. No outlet to the ocean of any considerable depth from Norfolk until Beaufort is reached exists. Albemarle and Pamlico sounds are from four to thirty feet in depth. The channel between the two sounds at Roanoke Island has changed greatly, being much increased in depth and width, to the entire destruction of several small islands. The waters of Albermarle Sound finding an outlet this way, has resulted in a measure, in closing the "inlets" on the seaward face.

The study of the interior coast region is very interesting and presents a fine field for the geologist. "The tract of land between Norfolk and Wilmington is chiefly a delta-formation of peat-bogs, swamps and savannas, bordered by bands, and intersected by tongues and islets of sandy and peaty soil." Some of the rivers are rivers of erosion but many more appear to be "wholly formed by the growth and encroachment of the marshes, peat-bogs, and alluvial sediment which has gradually excluded the waters of the sound. He is inclined to reject the theory of Dana that this is a region of depression and that the coast is now sinking. The growth of the peat moss often occurs in very deep water and there is nothing to show that the stumps on the bottom have not floated into their present position. The bottoms of the lakes, sounds and bogs is everywhere of sand, similar to the general coast. He also rejects the theory of many of the residents that the lakes in the interior, as for instance Lake Drummon in the middle of Dismal Swamp, are burnt out bogs. This may be so in some instances. The process of formation along the coast is thus described:

"First, the barrier-reefs of long, narrow islands are formed by the action of the winds, waves, and currents upon the shallow Atlantic slope, forming bays and sounds. Salt-marshes next begin to occupy the borders of these waters

The alluvium of the rivers forms many islands; oyster-rocks obstruct the channel and become the nuclei of shoals and subsequent marshes. The inlets are next closed by storms, or by the drifting sand; the water becomes brackish and marine life disappears. The salt-marshes now become savannas, which rise above tide and are covered with grass and a few juniper-trees. By the closing of inlets the water becomes fresh, or nearly so, and the *Sphagnum palustre* and other peat-plants begin to encroach on the sound. The peaty matter transported by currents closes the mouths of the channels and of the estuaries, and the water thus secluded becomes a lake, which may, in the end, become wholly a peat-bog. These appear to be the actual stages through which the swamp-lands are now passing, and are the more interesting as exhibiting, on a large scale, the preliminary process in the natural formation of extensive coal-beds."

THESE surveys are part of a scheme to establish a line of inland navigation from New York City to Florida and ultimately by ship canal across Florida and along the bays and sounds of the Gulf coast to Galveston, Texas. At the present there is in operation the Delaware & Raritan canal from New York to Philadelphia, 43 miles with locks 220 ft. x 24 ft. x 7 ft., and the Chesapeake & Delaware canal from Philadelphia to Baltimore, 14 miles with locks 220 ft. x 24 ft. x 10 ft. From Baltimore to North Carolina there are two routes, one by the Dismal Swamp Canal, 29 miles with small depth and small locks, the other by the Albemarle & Chesapeake Canal, 14 miles with one lock, 220 ft. x 40 ft. x 7 ft., and soon to be increased to 10 ft.

Farther southward the line has not yet been determined upon, and the object of this survey was to locate it as far south as the Cape Fear River at Wilmington. At present a good navigable channel of 7½ ft. can be carried from Norfolk to Core Sound. Two routes from this point were surveyed. One a coast line by Core Sound and the inlying sounds from Cape Lookout to Wilmington, 298 miles from Norfolk, estimated for a channel 40 ft. wide at bottom, 8 ft. deep, slopes 2 to 1, to cost about $3,700,000. Much of the distance is through shallow sounds which should be deepened in many places and connected by short lines of canal. The second was for an inland route; starting from the Neuse River near Havelock, the line runs nearly parallel to the coast and about 20 miles therefrom striking the N.E. branch of Cape Fear River 47 miles above Wilmington, to which point 10 ft. of water may be carried. The length of canal on this line will be 56 to 58 miles, and for a through-cut at tide level would cost $7,642,000 for a prism 40 ft. wide at bottom, 8 ft. deep, and slopes of 2 to 1.

Estimates were also made on a line with a summit 32 ft. above tide, of the same prism, to cost about $3,900,000. He does not recommend the adoption of any line until farther and more detailed surveys have been made. He states farther that the construction of this canal, "56¼ miles more between the Cape Fear and Waccamaw Rivers, and 45 miles between Winyah Bay and the Great Peedee River, will complete the communication with the harbor of Ferdinand, Florida."

A STUDY of the geographical and topographical features of the United States raises the question why some point on Chesapeake Bay, as Norfolk, blessed at it is with the finest roadstead on the Atlantic coast and holding an unequaled geographical position in respect to the region west of the Alleganies, was not made the commercial metropolis of this continent. An enquiry in regard to the early history of the country shows that it early had the

advantage, but with its growth the conservative policy of an influential class of landed proprietors, was foreign to the developement of commercial interests, and Virginia neglected to seize the opportunity which New York secured and holds. She could have constructed canals and railways at as small relative expense as New York and drawn through her ports the products of the Ohio Valley, settled at an early day, and also the Mississippi. The opportunity which she once lost she can never regain. She may build her trans-Alleghany canal, but, though it may help in a measure, as a whole she will be disappointed in its results.

The day of small canals is past, or in fact of any canals at all unless they form the links between long reaches of natural navigation and are of sufficient dimenensions to allow of the passage of boats adapted to the navigation of said waters.

To the south and southwest of Norfolk is an extensive region with hundreds of miles of internal coast line and navigable rivers, all to a greater or less extent, locked out from the sea by a cordon of sand along her front. It only needs a few miles of canal to bring this region of timber and other products within easy navigation of Norfolk by boats adapted to these sounds, bays and rivers, and then to all the ports of the Chesapeake and northward to Philadelphia and New York. Again, Norfolk lies in the track of ocean steamship lines already established, and a great region is given the advantage of a foreign market which it could not otherwise have.

When the whole internal system is completed from Norfolk to Florida the advantages to result from this internal coast navigation, by boats adapted to ascend the rivers, which cannot be said of the coasters now employed, can hardly be overestimated. Again, in a military or stratigecal point of view, a consideration we are fast losing sight of, the scheme is too important to merit but a passing notice.

In No. 28 of Engineering News we gave a short account of the project of making a lake in the desert of Algiers. Recent advices confirm the report and state that work will be commenced next year. The originator of the scheme is a captain on the French staff, M. Roudaire, who commenced his explorations in 1872. His report was warmly applauded by Gen. Chanzy and afterwards published in the *Revue des Deux Mondes*. The French government seconded the scheme and last year Capt. Roudaire was sent out to complete his explorations. After careful investigation and calculations he finds the formation of the interior sea of Algiers. with a length of 360 kilometres, and a breadth of 60, or about 217 miles by 37 miles, to be not only feasible but most desirable. A formal report was made in June and a more extended one accompanied by a map on a scale of 1-100,000 is shortly to be filed. The Tunisian government will bear its share of the expenses of construction, which are estimated at from 80,000,000 to 100,000,000 francs.

The work on the Fullerton Avenue Conduit in this city has come very nearly to a stand still, for the reason that the contractor does not see clearly when he is to be paid. The conduit proper is about two-thirds finished, and for the sake of public health, it should be pushed to an early completion. The North Branch has not been as much of a nuisance this season as in former years, owing to the prevalence of high water and the closing of the distilleries, although early in the spring it gave rise to many bad odors. These conditions will probably not be so favorable again for public health for many years, and no consideration of false economy should be allowed to interfere with a work which, when completed, will accomplish all that the most sanguine expect of it as a sanitary measure.

The value of the Centennial buildings is put at $5,949,000, and of their contents, $104,820,340. A large portion of the exhibits which are not taken into account, are not of intrinsic value, though probably they could not be purchased for all that the rest of the exhibition is worth.

CORRECTION.

On page 252 in the article "Carrying Azimuth on Long Transit Lines" about the middle of the second column it reads "Then at B 10′ in longitude from C, the 0° of the transit will be B P, etc." It should read B P′.

THE EROSION OF RIVER BEDS AND THE TRANSPORTATION OF DETRITUS.

In an article in the *American Journal of Science* for July and August, on "The Colorado Plateau Province as a Field for Geological Study," Mr. G. K. Gilbert gives some interesting conclusions in regard to the erosion of the Colorado Canons. In Part II., under the head of EROSION, he takes up the subject in a general manner, stating the laws succinctly, as based on a wealth of observations such as the canons only can furnish. Many of these conclusions are of great interest to the engineer and singularly apropos at the present time, and we propose in this article to give such of them as pertain to the erosion of river beds, and the laws which govern the trasportation of the materials of erosion by river currents.

He divides the process of erosion into three general divisions; (1) *weathering*, (2) *transportation*, (3) *corrasion*. "The rocks of the general surface of the land are disintegrated by *weathering*. The material thus loosened is *transported* by streams to the ocean or other receptacle. In transit it helps to *corrade* from the channels of the streams other material, which joins with it to be transported to the same goal."

After analyzing the forces which constitute weathering—as water which dissolves the cementing portion of rocks, producing grains, in which it is assisted by the product of vegetable decomposition; changes of temperature; beating of rains, and vegetation—he says: "In corrasion the agents of disintegration are solution and mechanical wear. Wherever the two are combined, the superior efficiency of the latter is evident; and in fields of rapid corrasion the part played by solution is so small that it may be disregarded."

"The mechanical wear of streams is performed by the aid of hard mineral fragments which are carried along by the current. The effective force is that of the current; the tools are mud, sand and bowlders. The most important of them is sand; it is chiefly by the impact and friction of grains of sand that the rocky beds of streams are disintegrated."

"Streams of clear water corrade their beds by solution. Muddy streams act partly by solution, but chiefly by attrition."

"Streams transport the combined products of corrasion and weathering. A part of the debris is carried in solution, and a part mechanically. The finest of the undissolved detritus is held in suspension; the coarsest is rolled along the bottom, and there is a gradation between the two modes. There is a constant comminution of all material as it moves, and the work of transportation is thereby accelerated. Bowlders and pebbles while they wear the stream-bed by pounding and rubbing, are worn still more rapidly themselves. Sand grains are worn and broken by the continued jostling, and their fragments join the suspended mud. Finally the detritus is all more or less dissolved by the water, the finest the most rapidly."

The conditions which affect the rapidity of erosion are divided into three heads: (1) declivity, (2) character of rock, and (3) climate. In regard to the first: "With increase of slope go increase in the velocity of running water, and with that goes increase in its power to transport undissolved detritus."

"The ability of a stream to corrade by solution is not notably enhanced by great velocity; but its ability to corrade by mechanical wear keeps pace with its ability to transport, or may even increase more rapidly."

Under the second head: "Other things being equal, erosion is most rapid when the eroded rock offers the least resistance," and again,—"Transportation is most favored by those rocks which yield by disintegration the most finely comminuted debris."

The effect of climate through vegetation is complex; the amount of rainfall, and its distribution through the year, give varying results, and the effect of frost depends on the saturation of the rocks.

"Transportation is favored by increasing water supply as greatly as by increasing declivity. When the volume of a stream increases, it becomes at the same time more rapid, and its transporting capacity gains by the increment to velocity as well as by the increment to volume. Hence, the increase in power of transportation is more than proportional to the increase of volume."

"It is due to this fact chiefly, that the transportation of a stream which is subject to floods is greater than it would be if its total water supply were evenly distributed in time."

In regard to vegetation—"Hence the general effect is to retard erosion; and since the direct effect of great rainfall is the acceleration of erosion, it results that its direct and indirect tendencies are in opposite directions."

After stating some interesting conclusions in regard to surface degradation in arid climates or those with slight rainfall, and again, in those of great rainfall, he takes up the subject of *Transportation and Comminution*, which is so interesting to engineers that we give it in full.

"A stream of water flowing down its bed expends an amount of energy that is measured by the quantity of water and the vertical distance through which it descends. If there were no friction of the water upon its channel the velocity of the current would continually increase; but if as is the usual case, there is no increase of velocity, then the whole energy is consumed in friction. The friction produces inequalities in the motion of the water, and especially induces subsidiary currents more or less oblique to the general onward movement. Some of these subsidiary currents have an upward tendency, and by them is performed the chief work of transportation. They lift small particles from the bottom and hold them in suspension while they move forward with the general current. The finest particles sink most slowly and are carried farthest before they fall. Large ones are barely lifted, and are dropped at once. Still larger are only half lifted; that is, they are lifted on the side of the current and rolled over without quitting the bottom, and finally there is a limit to the power of the current, and the largest fragments of its bed are not moved at all."

It may be well at this point to digress for a moment. D. Farrand Henry in his investigation of the flow of water in the Detroit River in 1867–'68, under the direction of the Lake Survey, discovered by means of the telegraphic meter, an irregular pulsation, due probably to this internal motion of the filaments of water. Capt. Cunningham, in his hydraulic experiments on a canal at Roorkee, India, in 1874, by means of light surface floats, made known the same irregular internal motion of a vertical, eddying nature. It is undoubtedly this internal eddying or whorl of the various filaments that gives to rivers their sustaining power. Humphreys and Abbott ascribed this agitation by which matter was held in suspension to the roughness of the bottom of the Mississippi River. That indeed might affect it, but it is very probable that the roughness of the bottom is more an effect than a cause, i. e., it is produced by this pulsating eddying motion in very much the same manner that sand is piled in small ridges by wind or even as the surface of sand bars is ridged by water in motion.

"There is a definite relation between the velocity of a current and the size of the largest bowlder it will roll. It has been shown by Hopkins that the weight of the bowlder is proportioned to the sixth power of the velocity. It is easily shown also that the weight of the suspended particle is proportioned to the sixth power of the velocity of the upward current that will prevent its sinking. But it must not be inferred that the total load of detritus that a stream will transport bears any such relation to the rapidity of its current. The true inference is, that the velocity determines the limit in coarseness of the detritus that a stream can move by rolling, or can hold in suspension."

"Every particle which a stream lifts and sustains is a draft upon its energy, and the measure of the draft is the weight (weighed in water) of the particle, multiplied by the distance it would sink in still water in the time during which it is suspended. If, for the sake of simplicity, we suppose the whole load of a stream to be of uniform particles, then the measure of the energy consumed in their transportation, is their total weight multiplied by the distance one of them would sink in the time occupied in their transportation. Since fine particles sink more slowly than coarse, the same consumption of energy will convey a greater load of fine than of coarse."

"Again the energy of a clear stream is entirely consumed by the friction on its bottom; and the friction bears a direct relation to its velocity. But if detritus be added to the water, then a portion of its energy is diverted to the transportation of the load; and this is done at the expense of the friction upon the bottem, and hence at the expense of velocity. As the energy expended in transportation increases, the velocity diminishes. If the detritus be composed of uniform particles, then we may

also say that as the load increases, the velocity diminishes. But the diminishing velocity will finally reach a point at which it can barely transport particles of the given size, and when this point is attained, the stream has its maximum load of detritus of the given size. But fine detritus requires less velocity for its transportation than coarse, and will not so soon reduce the current to the limit of its efficiency. A greater per cent. of the total energy of a stream can hence be employed by fine detritus than by coarse."

"Thus the capacity of a stream for transportation is enhanced by comminution in two ways. Fine detritus, on the one hand, consumes less energy for the transportation of the same weight, and on the other, it can utilize a greater portion of the stream's energy."

"It follows as a corollary, that the velocity of a fully loaded stream depends (*ceteris paribus*) on the comminution of the materials of the load. When a stream has its maximum load of fine detritus, its velocity will be less than when carrying its maximum load of coarse detritus; and the greater load corresponds to the less velocity."

"It follows also that a stream which is supplied with heterogeneous debris will select the finest. If the finest is sufficient in quantity, the current will be so checked by it, that the coarser cannot be moved. If the finest is not sufficient, the next grade will be taken, and so on."

In considering the relation of "*Transportation and Declivity*," he supposes two streams having the same length, equal quantities of water, beds of same character, each loaded to full capacity with detritus, but differing in total fall. The velocities of the two streams, depending on the character of the detritus, are the same; hence the energy spent in friction is the same, *i. e.*, the stream with the greater slope having the greater energy, will spend a less per cent of it in friction, and a greater per cent in transportation. "Hence declivity favors transportation in a degree that is greater than its simple ratio."

In a subsidiary clause he mentions two elements which are not considered in the preceding discussion, viz: "the addition which the transported detritus makes to the energy of the stream," a stream thus charged being in the nature of a compound and unstable fluid requiring a constant expenditure of energy to maintain its constitution, and again of greater energy in the precise ratio of the mass of the mixture to the mass of simple water; second, the addition which the detritus makes to the friction of the stream. The friction of the compound stream upon the bottom to which the corrasion of the stream bed is due, represents for a given velocity a greater amount of energy consumed.

After stating the relation of wetted perimeter, cross-section, slope and velocity he says, "that the running water which carries the debris of a district loses power by subdivision toward its sources; and that, unless there is a compensating increment of declivity, the tributaries of a river will fail to supply it with the full load which it is competent to carry."

This point is nicely taken and is confirmed by the fact that in all sediment-bearing rivers the slope varies as some inverse ratio to the volume. In any basin where the material is such that the bed of the river is free to sink under the action of the various forces brought against it, this equilibrium must finally establish itself and the lower river be maintained in a condition of saturation. If the character of the basin and of the beds of the tributaries are such that the erosion does not give this proper relation of slope to volume then it must follow that the lower river will be constantly "undercharged."

"A stream which can transport debris of a given size, may be said to be *competent* to such debris. Since the maximum particles which streams are able to move are proportioned to the sixth powers of their velocities, competence depends on velocity. Velocity, in turn, depends on declivity and volume, and (inversely) on load."

Farther in regard to capacity of streams: "Its capacity for the transportation of a given kind of debris is enlarged in more than simple ratio by increase of declivity; and it is enlarged in more than simple ratio by increase of volume."

"The competence of a stream for the transport of debris of a given fineness, is limited by a correspondent velocity."

"The *rate* of transportation of debris of a given fineness, may equal the capacity of the transporting stream, or it may be less. When it is less it is always from insufficiency of supply. The supply which is furnished by weathering is never available unless the degree of fineness of the debris brings it within the competence of the stream at the point of supply."

After tracing minutely the process by which streams get their supply of debris he says: "When the current of a stream gradually diminishes in its course—as, for example, in approaching the ocean—the capacity for transportation also diminishes; and so soon as the capacity becomes less than the load, precipitation begins,—the coarser particles being deposited first."

In regard to *corrasion*: "If a stream has no load of detritus, it corrades only by solution. If it is loaded to its full capacity, it does not corrade; it is on the verge between corrasion and deposition. Only with a partial load does a stream wear its bottom."

After deducing a few more principles which have a more direct application to the canon region, and making the application of the principles to that region, he attacks the "*Problem of Waterfalls.*"

When rivers descend a slope that is terraced by the alternation of hard and soft strata, they are apt to leap from the edges of the hard beds in waterfalls. But the Colorado, notwithstanding the favorable condition of its bed, makes no leap. The limestone resists all erosive action as strongly as does the Niagara limestone, and the sandstone yields to it as easily as does the Niagara shale. But, instead of plunging from one to the other in a great cataract, the Colorado cuts the two with nearly equal grade of channel. Its average descent in the hard rock is ten feet to the mile, and in the soft, less than five feet."

It becomes evident that some condition is involved besides the constitution of the rock. Such condition the writer finds in the relation of corrasion to transportation.

"Let us suppose that a stream, endowed with a constant supply of water, is at some point continuously supplied with as great a load as it is capable of carrying. For so great a distance as its velocity remains the same it will neither corrade nor deposit, but will leave the grade of its bed unchanged. But if in its progress it reaches a place where a less declivity of bed gives a diminished velocity, its capacity for transportation will become less than the load and part of the load will be deposited. Or if in its progress it reaches a place where a greater declivity of bed gives an increased velocity, the capacity for transportation will become greater than the load and there will be corrasion of the bed. In this way a stream which has a supply of debris equal to its capacity tends to build up the greater slopes of its bed and cut away the steeper. It tends to establish a single, uniform grade."

"Let us suppose that the stream, after having obliterated all the inequalities of its bed, loses nearly the whole of its load. Its velocity is accelerated and corrasion begins through its whole length. Since the stream has the same declivity, and consequently the same velocity, at all points, its capacity for corrasion is everywhere the same. Its rate of corrasion, however, will depend on the character of its bed. Where the rock is hard, corrasion will be less rapid than where it is soft, and there will result inequalities of grade. But so soon as there is inequality of grade there is inequality of velocity and inequality of capacity for corrasion; and where hard rocks have produced declivities there the capacity for corrasion will be increased. The differentiation will proceed until the capacity is everywhere proportioned to the resistance, and no further,—that is, until there is an equilibrium of action."

In conclusion, "When its work is to transport, the resistance is constant, and the fall is evenly distributed by a uniform grade. When its work includes both transportation and corrasion, as is the usual case, its grades are somewhat unequal; and the inequality is greatest when the load is least."

By way of illustration: "The water of Niagara is nearly devoid of load. * * * * * * The work of transportation is at a minimum, and the differentiation of slope dependent on rock structure reaches its maximum in a cataract."

"The water of the Platte is supplied with all the load it can move. * * * * * Its mean declivity is as great as the Colorado, and it would have carved canons of imposing depth, if only the material of its banks were sufficiently coherent to stand in walls. As it is, the loose sands of the bordering plains are washed and blown into the river, and, its energy being consumed in their transportation, the corrasion of its channel can proceed no faster than the general degradation of the plain. Having little work to perform beside the transportation of its load, it maintains an almost uniform slope from the foot of the mountains to its mouth."

"In that portion of the Colorado which is contained in the Plateau province, the load consumes a share of the energy of the stream and leaves to corrasion the remainder. The slopes of the stream-bed are varied, but not so greatly as those of the Niagara. Where the bed-rock is soft the declivity is small. Where it is hard, the declivity is relatively great; but in the toughest hornblende rock the mean angle does not exceed three degrees."

We believe many of the conclusions above given are new, especially those which relate to waterfalls. The abstract which we have given is necessarily imperfect and devoid of illustration, and we refer those of our readers who may take a further interest in the subject to the article in question.

NOTES.

Recent experiments on placing zinc in boilers in order to prevent incrustations, have met with considerable success.

According to an Oil City newspaper, the total number of tanks in the oil regions is 484, with a total capacity of 6,277,730 barrels.

The first wire of the East river bridge was stretched across the river Aug. 14th. About 5,000 people were present and considerable enthusiasm was manifested.

A new department of the University of Michigan at Ann Arbor, the School of Architecture and Design, will be opened for the first time with the coming college year.

The New York State Board of Audit are fighting Baxter's claim for the award of $100,000 offered by the state in 1871 "for an invention which should supersede animals as a motor power on the canals."

Sir John Hawkshaw, on examination, pronounces the Lake Huron and Ontario ship canal feasible. If this canal should be constructed it would save between 300 and 400 miles from Chicago to all points on Lake Ontario, and much dangerous navigation.

Work has commenced on the water works improvement at Oregon, Ill. The race is to be 340 feet long, 50 feet wide and 15 feet deep, with walls of four feet thickness, and will be completed about Nov. 1st. There is a splendid water power at this point awaiting development.

Toward the end of this month the first of a monthly line of steamers will leave New Orleans for the ports of Savanilla, Laguira, Port of Spain, Georgetown, Cayenne, Pernambuco and Rio de Janiero. The run from New Orleans to the near ports will be made in six or eight days, and to Rio in twenty-eight days.

The *Telegram* says that Hell Gate is to be exploded postively on the afternoon of Tuesday, September 5. The explosives used will consist of nitro-glycerine, dynamite and rendrock—65,000 pounds in all. All the discharges will occur simultaneously. To obviate any severe shocks, as well as to render the blast as effectual as possible, the excavations are to be flooded with water.

In regard to the cut-off on the Mississippi at Vicksburg the *Herald* says: "Just as we predicted before it occurred, the cut-off has been a benefit to the city instead of an injury. It has relieved the suspense in regard to the matter, without inflicting, as yet, the least damage, and with nothing worse to fear in the future than possibly a small outlay to keep the harbor clear."

The following table gives the weights of U. S. silver coins.

	Grains.	Hundredths of oz.
Trade Dollar	420	87½
Half Dollar	192.09	40
Quarter Dollar	94.45	20
Twenty Cent	77.16	16
Dime	39.58	08
Half Dime	19.29	04

Improvement of the Fox and Wisconsin Rivers.

BY S. L. DOLEEN, C. E.

[Written for Engineering News]

The project of forming an improved water communication, between Lake Michigan, at the upper end of Green Bay and the Mississippi River at Prairie du Chien, dates far back in the time when the territory, through which the proposed improvement lies, was still in its state of primeval wilderness, and under territorial government.

The first official examination of which we have any account, was made under the direction of the War Department of the Government, by Capt. Cram of the Topographical Engineers U. S. A. in the year 1839.

In the year 1846 a grant of land was made by the General Government to the new state of Wisconsin, to be applied to the improvement of the navigation of the Fox and Wisconsin Rivers, the work being carried on under the auspices of a Board of Public Works organized for that purpose. In 1853 the work was turned over to a private corporation, and in 1854 and 1855, the grant was confirmed to this company, and still further enlarged by additional acts of Congress.

From this date the work of improvement, especially on the Fox River, made some progress, but after varying fortunes, the franchise reverted in the year 1866, to the General Government.

But the final transfer was not made until Oct. 1st 1872. The value of the improvements was arbitrated in the mean time, the value exclusive of water power rights being estimated at $868,070. From this was deducted the amount realized by the sale of lands granted by Congress to the State of Wisconsin, and the balance $145,000 was appropriated by an act of Congress approved June 10th 1872, for the purchase of such of the property as was relevant to the purposes of navigation.

Pursuant to instructions of July 1866 from the Engineer Department of the Government, surveys were inaugurated under the supervision of Maj. G. K. Warren, U. S. A., and the plans and estimates for the entire route were carefully revised.

This survey of the Wisconsin River was probably the most thorough and exhaustive examination of that stream that had yet been made. A continuous transit line was carried along the main river on the side most practicable, and the topography carefully noted, the opposite side being tied in by frequent triangulations. Compass lines, tied to this transit line, located all minor channels, chutes, etc. A careful line of levels fixed the elevations of the water surfaces, the crests of sand terraces when near, and the extreme variations of noted high and low water marks.

Cross-sections of the river and valley were made where deemed necessary, and the entire section of the river proposed to be improved, was carefully sounded.

The distance made, following the line of the river to Prairie du Chien, was 118 miles, and the total descent, 169 feet.

As the result of this examination Maj. Warren submitted three propositions for solving the problem of the proposed improvement of this division of the route.

1. By means of a series of wing-dams etc., and the use of Long's scraper, providing navigation for boats of three feet draught; estimate $428,000.

2. By use of natural channels in connection with side-canals of sufficient width and depth to pass boats of four feet draught; estimate $3,207,000.

3. By means of a canal, designed for boats drawing five feet of water, built along the valley and alternating from side to side of the river as circumstances demanded, using the natural bed of the river for crossings; estimate $4,164,000.

The hypothesis of these propositions, presumes a river possessing generally all the physical characteristics common to streams of that region. Ranges of bluffs, from 100 to 400 feet in hight, composed of Silurian limestone in horizontal strata, rise on either side of the river, forming a valley from one to ten miles in width, interspersed with long stretches of level sand terraces, rising from 20 to 60 feet above the level of the water, seldom of great extent except on one side at a time, and rarely or never subject to overflow.

These bluffs and terraces limit the extent of the bottom lands, a labyrinth of islands of rich alluvial soil and luxuriant vegetation, formed by innumerable chutes, side-channels, etc., and subject to frequent overflow. Besides these, there remains the bed of the river proper, composed chiefly of sand, covered with water at high stages, but exposing large areas of dry sand bars, at a medium or low stage of water.

One feature, although properly not belonging to this division of the river, should be carefully considered, and its present and future bearing on the proposed improvement noted; namely, the vast formation of friable sandstone (St. Peters) existing on the headwaters of the river above the Dalles; the location and formation of the Dalles itself, and its bearing on the volume of water and sand supplied through it to the river below. This investigation is of great moment in considering the advisability of the adoption of the first of the above propositions, or any proposition tending to a modification of the same. The Dalles is a narrow gorge in the rock, about 23 miles above Portage, contracting the river to a width of 54 feet, and while the variation above from extreme low to high water is from 40 to 50 feet, below it has never been known to exceed 10 feet.

The third of these plans was recommended by Maj. Warren, as the most practicable for obtaining a reliable navigation, and was, in detail, a canal starting from a point on the canal connecting the Fox and Wisconsin Rivers, near Portage City, and proceeding on the left bank of the river to a point about 4⅝ miles below Portage City, where it connected by a lock with the river. The canal again commenced on the opposite side of the river and proceeded on the right bank to a point about 56⅛ miles below Portage, where it again connected with the river by a lock. Crossing the river to the opposite bank it proceeded to a point 88⅝ miles below Portage where a similar crossing became necessary, and the canal proceeded on the right bank to Prairie du Chien, where it connects with the Mississippi River 106 miles from Portage.

In 1871 Major D. C. Houston U. S. Engineer, was placed in charge of the proposed improvements, and commenced making experiments with wing-dams and dykes, constructed of fascines of brush, in those sections of the river where the proposed canal was to cross, and the following interesting data of the results of these experiments and subsequent works of improvement is derived chiefly from his reports and those of his assistants.

The total length of dams and dykes built during the season of 1871 was 6,600 feet at a cost of $30,000. The works were confined entirely to the upper and middle channel-crossings, and were almost entirely experimental in their character.

The construction of the dams or dykes used in these works was very simple and inexpensive in its character, the material consisting of brush, stone and sand.

The brush being made up into fascines of 11 feet in length, and from 13 to 15 inches in diameter, mats about 9 feet in width were constructed by placing these side by side with a light pole placed across the top and bottom, the ends being securely tied with twine.

The location of the proposed dam or dyke having been determined, the mats were towed into position, being placed side by side with the tops or brush ends against the current, and thus sunk by being weighted with sand bags, each succeeding course being brought forward in the form of steps of from 2 to 4 feet in width, to break the fall of the water, a quantity of loose gravel being thrown on the tops of each for the purpose of preventing undermining. After being carried from 12 to 18 inches above the surface of low water, the front or face was still further strengthened by a substantial layer of loose brush weighted by stone, and covered with loose gravel, sufficient to stop all leakage.

As the work progressed, observations were made on the sand movement, and the character and general features of the new deposits carefully studied. The rapidity of this movement depended, of course, on the natural characteristics to be overcome, and above the dykes the movement seems to have averaged from 5 to 20 feet, receding and disappearing on reaching them, the sand being deposited behind them.

In all 22 dams and dykes were constructed, and their effect was, necessarily, to decrease the wetted perimeter of any cross-section of the river in their vicinity; and therefore to increase the elevation of the water surface as well as the mean velocity of the current.

This resulted in moving the sand particles from the bed of the river, and consequently in increasing the depth of volume of water passing, until an equilibrium was attained between the specific gravity of the sediment composing the bottom, and the velocity of the current. But since the velocity of the water depended not only on the inclination of the surface, but also upon the extent of the superficial surface over which it flowed, it followed that a decrease in the extent of this surface, resulted in an increase of the mean velocity of the current, the ratio of this increase varying inversely as the perimeter of the cross-section.

But as this increased velocity was an element to be avoided in the interest of navigation, it was proposed to equalize it by diminishing the inclination of the surface, i. e., increasing the length of the stream. To accomplish this it was proposed by an arrangement of dykes, alternating from either shore, to produce artificial sand deposits above and below the dykes, concave above, and convex below, parallel to the axis of the stream.

Examinations were made to determine the most favorable condition of equilibrium to secure and preserve a good channel. Careful tests were made of the specific gravity of the sediment forming the bed of the river, and it was found to increase in density with the depth below the surface. A cross-section 320 feet in width between banks and mean depth of 6 feet, giving an area of 1,950 sq. ft., with a velocity of 1.95 miles per hour was found to possess the necessary functions of equilibrium, and assumed as the required cross-section.

As the result of these experiments, and works afterwards constructed on the same plan, Maj. Houston, in his report of 1873, to the Chief Engineer of the Army, assumes the adaptability of this system for the improvement of this section of the proposed route to be demonstrated.

The "portage" or divide between the Upper Fox and Wisconsin Rivers is a level sandy prairie without rock. The bed of the Wisconsin at this point, like that of most streams, carrying large quantities of sediment in solution, is higher than the general elevation of the surface on either side, and the canal across the divide has a fall of 8 feet in its length of two miles. This fall is overcome by a lock of 8 feet lift at its junction with the Fox, the lock on the Wisconsin being merely a guard lock. When the government assumed possession of the property, this canal was found to be about 70 feet in width, much choked by sand, and required thorough dredging and some repairs.

The navigation of the connecting link between Portage and Green Bay, a distance of 160 miles, by the line of the Upper Fox River, Lake Winnebago, and the Lower Fox River, had been, as before stated, considerably improved, when the proscution of the work reverted to the Government. The Upper Fox had a low water channel of about 3 feet, and the Lower Fox, from Oshkosh to its emboucher into Green Bay, about 4 feet.

The improvements consist of dams extending across the river with short lines of canal around one end of them, connecting by locks with the river; the total length of these short canal connections is about 6 miles. The total descent from Portage to Green Bay is about 200 feet, but the lockage overcome is only about 195 feet, the difference being due to the fall allowed in the levels. In all there are 22 locks 160x35 feet, and 16 levels.

The annual appropriations, since Government assumed the control of the works have not been to exceed $300,000.

The inadequacy of this sum for the purpose designed, is evident, when we consider the nature of the improvements contemplated, and their estimated cost, between three and four million dollars. At this rate it will take from 10 to 12 years before the route can be opened to navigation, while from the statement of the officer in charge we are assured that more than half that time could be saved, by doubling the amount of the yearly appropriations, to say nothing of the saving in necessary working expenses. The idea of utilizing the Wisconsin River, instead of building a canal for that section of the route, involved great difficulties, from the very presence of large volumes of water, in any attempt to modify the bed of that steam. But from the examinations made, and

the data collected, we are satisfied that the work can be prosecuted to a successful conclusion, by adhering to the plans of permanent works at present adopted.

Engineering Instruments at Philadelphia.

[Special Correspondence of Engineering News.]

II.

Among the most prominent exhibits of this class is that of Messrs Heller & Brightly, of 33 N. 7th St., Philadelphia. This is the firm that have done more than any other in this country of late years to increase competition in the trade, and to wake up the different makers to a sense of the many improvements that may be made in the instruments in common use. Indeed, it was said of them by one of their powerful rivals that they had made more progress in the manufacture and improvement of their instruments than any one else. The gentleman really went further than I am ready to accompany him when he said that they were the only ones who had advanced much, if any, from previous practice. Whilst I regard this as far from an exact statement, it illustrates the respect in which they are held by those who compete against them. They have on exhibition a fine collection of their various products. Here is a list of what may be seen: Two engineer's Y levels, complete transit for mining use, plain engineer's transit, geological transit, 4-inch limb; tunnel transit, used at the Musconetcong and Nesquehoning tunnels; surveyor's compass; solar transit, Benj. Smith Lyman's patent solar apparatus beneath the plate; mining and reconnoisance level; combined transit and levelling instrument; two mining and reconnaisance transits, 5-inch limb; large mining transit, 7-inch limb; and a plane table. Now there is not one of these instruments that does not show in some one or more ways the inventive genius of the firm. There are numerous details worked out and devised to improve upon old ones. It gives great pleasure to be able to say that in almost every instance the change is an improvement. This, however, is not always the case. Besides, it is a matter of opinion as to what are improvements. It can be said with great force that in the work of this firm is the place to hopefully look for real improvements. Whoever is to invest in instruments should give them an examination. It is of course quite impossible to mention all of the devices shown here, but a few will be given. The large mining transit has an adjustable lamp stand provided with it. This stand may be easily fastened upon one of the legs of the tripod and may be quickly set so as to support a lamp at the proper place for illuminating the cross-wires or for reading the verniers. The same transit is provided with an extra detachible telescope on the end of the transit axis for sighting in a vertical direction. The device for attaching this telescope is neat and efficient. There is also shown a large 15 second transit with three levelling screws. This instrument is provided with an arrangement of parts in the tripod cap that operates in a manner to accomplish the same result as is accomplished by the ordinary shifting tripod cap, or "shifting tripod" as it is called. I think this arrangement for a three screw instrument is new. The alidade to the plane table has the movable edge to the rule that is made by this firm for those who desire it. I will say in passing that an edge of this kind to a rule, whilst it may introduce no appeciable error into the work, is not a mechanically perfect construction. The whole trouble which this device is intended to meet, and many others besides, can be fully overcome, or avoided, by setting the centre of the board over the point from which observations are to be made, with a plumb-bob, in the same manner that a transit is usually set. Another interesting invention is a device for detaching an instrument from the tripod head at the upper parallel plate. The height of the instrument is not practically increased.

In closing my remarks about the exhibits of this firm I wish to say that I think their most valuable contribution to the advancement of their business is the spirit of invention and adaptation which they have awakened amongst their competitors. Since I believe we have not seen the full development of good principles of construction in our common instruments, I look for particularly valuable results from the spirit above alluded to. Whilst I regard with satisfaction the disposition of engineers to adhere to a well tried and valuable types of construction in any department I am sure this conservatism may be carried too far and much be lost thereby. I think this has been the case with those who have had to use engineer's instruments. I am of the opinion that much has yet to be done to induce men to be ready and willing to try any new device applied to these constructions. The practice in this regard seems to have improved much within a few years, but there is much to be done. It is in the hope that these remarks may lead some to consider this matter that they are writtten.

I cannot close my account of this firm without mention of the excellent plummet lamp shown by them. One is provided with a "compensating ring" which is simply a ring upon the sides of which rest two trunnions, from the plummet and from opposite sides of 90° from the other points proceed two light chains which meet some ways above the plummet where the string is attached; the lines of the attachment of the chains and the bearings of the trunnions are consequently at right angles with each other. Another has, in addition to this ring, in the place of an ordinary burner a safety lamp. Both arrangements are the invention of Professor Eckley B. Coxe.

The next visit was paid to the exhibit of Wm. Kuebler, of 925 Sansom St., Philadelphia. Here is shown a very original instrument and the photograph of another. The one exhibited seems to be of the greater practical value and I will attempt a description of it. First, it is a transit with a large plate. This transit has the wyes so shaped, in curved lines, that at about midway of their height there are rests formed similar to the rests in the wyes of a common Y level. Into these rests can be placed and fastened a telescope resembling a level telescope. Its line of sight when in this place is at right angles with the plane of revolution of the line of sight of the transit telescope. The instrument can now be used as a level. The size of the plate is such that the wyes are far enough apart to separate the bearings of this level telescope sufficiently. The level telescope has a long level table attached as in the common level. There is provided an axis which may be put right in these bearings when the level telescope is removed. On the end of this axis is a graduated circle, to act presently as a vertical circle, and a device by means of which the lev el telescope can be readily and securely attached to and at right angles with the axis just put in its place. The instrument as now mounted has the level telescope in position to revolve in a plane parallel to the plane of revolution of the transit telescope. It will turn past the edge of the plate and so may be used for sighting in a vertical direction. Vertical angles can be read by means of the circle above named. The name of this instrument is the "Universal Theodolite." The term theodolite is unfortunate as it is not a theodolite at all, but the other seems quite appropriate provided such an instrument is found to perform all its functions satisfactorily. When the level telescope is in either of its positions of attachment the transit telescope can be turned through a greater vertical angle than is almost ever needed in ordinary work, but cannot be reversed. Having given the matter a little thought I will say that I see no trouble in making the adjustments now; but of their permanency I can form no estimate. Those who have used such an instrument can soon clear up these points. The extra telescope and attachments are capable of being easily disposed of when not wanted.

The remarkable instrument of which photographs are shown I am not able to give much of an account of. The telescope is mounted by a side axis on the end of a strong bar which is attached by a joint at its other end to the edge of the plate, These parts are balanced by a weight on the opposite side of the plate. There is a graduated circle on the telescope axis and at the connection of the bar on which it is mounted with the plate. It appears from a casual look at the photographs that such an instrument could be used to run an oblique section, like the side of a cut or a fill on a railroad, as well as a vertical one, like the center line. If the instrument is made for this purpose it seems to be open to the usual insurmountable, practical objection of its being exceedingly difficult to get the line of sight to revolve in exactly the oblique plane required. There is no difficulty in setting it to revolve in a plane parallel to the one wanted, but the trouble is to set the instrument for the required one. Perhaps the maker will be pleased to give us an account of this invention.

There is also shown an excellent level. The criticism to be made upon it is that it stands up too high above the parallel plates. It is unnecessarily high at this point.

I had determined to say that a maker who exhibited so much ingenuity and made such important changes deserved to have his work investigated and critically examined by those interested, for the *workmanship* is good, when I saw that this is just what Mr. Kuebler invites and heartily desires. I also find that he says his instruments are now in use and recommended by the following gentlemen:

J. H. Simson, Col. of Eng., U. S. Eng. Office, Mobile, Alabama.

H. D, Whitcomb, Chief Eng. Chesapeake and Ohio Railway.

Walter McFarland, Major of Eng. U. S. Eng. Office, Chattanooga, Tenn., and by other eminent engineers, Those who avail themselves of the invitation to examine and investigate will be cordially received I am sure.

J. B. D.

Engineering Field Work.

[Written for Engineering News.]

IV.

In our last paper we touched upon some of the duties of the Transitman and Levelling party in a preliminary survey, and now we propose to discuss the duties of the rest of the transit party, viz, the chainmen and axemen. To these men are sometimes added "front and back rodmen," but in our practice we have always had the head chainmen hold the front rod, and for preliminary lines the line of stakes already set, or a strip of peeled brush (willow shoots are best for this) set at the last transit station by the transitman himself after taking up his instrument, will save a man or boy in the party.

The head chainman holds an important position and must be a man with sound judgment, and must understand his work. He should hold the transit rod with one hand, and the chain with the other, should use discretion as to holding the chain level and taking short lengths on hilly ground; he should understand the signals of the transitman and obey them intelligently; should have a good eye for line and use it every time he holds his rod up so as to be as nearly right as may be before the transitman begins to signal to him; and he should always look at the transitman when lining instead of gazing around at other things. His work is perhaps best conducted in the following order,—When the chain is pulled out he turns around, and holding the rod with one hand, tries to place it as nearly correct as he can by lining over the last stake to the instrument, while with the other hand he is trying to "straighten out the chain; he then moves the rod in obedience to the motions of the man at the instrument, and after getting the line, holds the chain up to the rod with both hands and gets the distance; then dropping the chain he stands up straight, plumbs the rod carefully, and re ceives the line again; then pressing the rod into the ground he makes a hole with the point, and takes it off the ground; a stake is then driven and the measurement should be repeated to see if the distance is correct, after which the rod is held on the stake "for line," the chain is then dragged on and the operation repeated. Time may be lost by neglecting the order of operations given above, or by not looking to see where the line is, and leaving all the movements to be signalled from the instrument, or by jerking the chain while trying to straighten it, or by not watching the transitman closely, and thus missing his signals. If you are so far away that the motions can not be seen, take your handkerchief or hat and make a signal (imitating the lining signals) and the transitman will understand that you wish him to take his handkerchief, (when snow is on the ground, his hat) to increase the visibility of his signals. Remember that the transitman can see you plainly, and can guess what you may wish him to do. When you wish him to line you hold up your rod and wave it to catch his eye, and when you are sure that the line can go no further without a change in the position of the instrument you must call his attention by holding your rod in both hands horizontally above your head; then after carefully lining and centering, you can call him np by beckoning with both hands, holding the rod above your head, or by any other previously arranged signals.

By far the most important duty in point of difficulty is the selection of the transit points, which must be so chosen that the greatest distance ahead may be seen

from them; in general they should be on the upper edges of hills where a view of the valleys on both slopes can be obtained, and, if possible, where a full view of the transit rod can be had, as it is only allowable in cases of necessity to sight at only a small part of the rod, and therefore great care must be taken to hold "plumb" at all times, as you do not know just how much of the rod may be observed. You must exercise considerable judgment in the matter and never be astonished if your views and the transitman's differ on this point. And here let us say a word to all the men; remember that the transitman has to work all the time, and that he has to take all the blame from the engineer-in-charge for all mistakes, and that if he does scold you for things that are not your fault, just wait till the matter develops, but do not try to argue during working hours about the work; if you have been to blame you deserve "jawing," and if you have not it will not hurt you a bit in the eyes of anybody whose opinion is worth having. The same remarks will apply to the transitman and levellers in their relations to their superior; let them remember that the engineer-in-charge has more things to think about in a day than they have in a week, and if they don't believe it, wait till they have the same position and can see for themselves.

The work of the rear chainman is to hold the chain while it is being pulled along, we say hold it, for if you let the end go you may have to call the front chainman back for ten or twenty feet after he has passed his proper distance, and he wont like that. Dont hang on the chain and be dragged by it, but be ready to give it a shake and clear it if it catches on brush or rocks. The hind chainman is responsible for the numbering of the stakes, and for all distances with "plus" numbers; he must be careful to assist in straightening the chain, to be on hand promptly in measuring, and not get in the line nor walk on the line, and not to jerk the front chainman's arms off by suddenly stopping. The keeping of the numbers right is a more difficult task than it seems to be, and requires a good memory; in all cases of doubt, go back and find out at the last stake what is right and don't guess at it. Be careful that the chain is in good order—that the links are straight and that the rings are not pulled open. Do it up from the middle, and keep a strap round it; learn to throw a chain over a stream; one end of an ordinary heavy chain can be thrown over a fifty foot stream, and by making two bundles with say 15′ between them and using two men to throw, one after the other, (at say half a second interval) we have thrown the end of a heavy chain seventy-five feet. Be careful that the chain is not dragged against the transit legs, and do not hit them while trying to stand the straightening process as inflicted by the head chainman; be prompt to assist in making short chains on hilly ground, and on curves, if there are any, and walk on the outer side of the line lest you get in the "line" of the instrument without knowing it.

The axemen are under the general direction of the head chainman who gives the line for cutting brush and timber with his rod. One axeman must be in charge of the stakes and must never let the chain work wait for him a second but must keep up at all risks. Sometimes a large basket is useful in carrying stakes. The stakes should be numbered by the rear chainman, and if he marks a number of them in the basket, care must be taken to see that in "plus" stations the numbered stakes are not used or the numbers may get "mixed."

In location surveys the only difference in the work of the men is in the curve work where the head chainman has to offset from the line of the last stakes to find the transit "line" by an amount known as the "chord deflection," for which see "Henck's Field Book." We always gave the chainman a list of "chord deflections" for the even degrees and let him guess at the amount on the ground, and found that it saved time. The centering of the stakes should be attended to a little more carefully than on preliminary work, and the measurements made with more care.

A back rodman will be necessary, and we can only caution him to stand up, with his rod in position all the time, or if near enough to see, whenever the transitman turns over his telescope he must be on hand. Although the job is not very interesting it is important. We used to let the back rodman carry the coats, and if we took our dinners along, a basket with the "grub."

Each man in the party must be held strictly responsible for what tools or instruments are put into his hands, and a careful property account must be kept and reported from time to time.

The work of the transitman and of the engineer-in-charge is so much increased by location that we must defer a discussion of it till our next article S.

Railway News.

It is expected that the Southern Pacific Railway will be completed to Fort Yuma by November.

The North Shore Railway of Canada have over 2000 men at work between Quebec and Maskinonge.

The Kings Mountain tunnel, 4400 feet long, has been completed on the Cincinnati Southern Railway, in Lincoln county, Ky.

Out of 691 railways, only 166 paid any dividends last year, and of 246 in the Western States, only 34, and out of 109 in the South only 19 paid anything.

One mile of track is laid on the Rock Island & Mercer County Railway, Iowa, starting out from the Milan depot, and construction trains are using it.

The Chesapeake and Ohio canal extension committee met at Cumberland, Md., on the 15th inst. to confer with the canal board in reference to constructing a proposed new railway to the Maryland coal fields.

A railway from some point on the Union or Central Pacific Railway in Utah by the valleys of the Snake and Columbia rivers to Portland or Puget sound is advocated by Salt Lake papers. Also a road by the Colorado Valley to San Diego in Southern California.

Eighteen miles of the Peoria & Fond du Lac narrow-gauge road are now graded, and unless some unforeseen circumstances arise the iron will commence being laid in a few days. All that is now retarding the operations of the company is a lack of the right-of-way.

Work is to commence soon on the Rhode Island and Mass. Railway, which will run from Valley Falls to Frankline. The Diamond Hill quarries, from which the granite for the Poughkeepsie bridge is to be taken, are on this line. The Boston & Poughkeepsie Railway survey is about half completed.

The work on the Port Huron & Lake Michigan railway is now being pushed vigorously toward completion. About 300 men are at work between Flint and Lansing. Arrangements have been made by Mr. Bancroft for the shipment of 500 tons of rails weekly, commencing next week, the rails to be laid at once to the end of the route.

People are not generally aware says the *Cincinnati Gazette*, of the cheapness with which railways can be built at this time. The Columbus and Toledo railroad, a road of the usual gauge, a first-class road in respect to grades, alignment, rails, etc., with the rails one-half steel, is now approaching completion, at a cost of $15,000 per mile.

A company called the Golden, Georgetown & Central has been organized in Colorado to build a narrow-gauge road from Floyd Hill, the terminus of a branch of the Colorado Central, up Clear Creek to Idaho and Georgetown, with the intention of extending it hereafter through Berthoud Pass into the Middle Park. There is also to be a branch to Central City. A preliminary survey has been made and a small force put at work on the grading.

The Western Maryland railway has made arrangements with the Chesapeake and Ohio canal for freight from Baltimore to Cumberland. Freight will be received at Baltimore and transferred to steamboats at Williamsport and will reach Cumberland in 36 to 40 hours. Freight sheds will be erected at Cumberland so as to make it as convenient as a railway station. The rate will be 15 to 20 per cent. less than the Baltimore and Ohio Railway with which it is intended to compete.

An interesting trial of locomotives is now going on over the Boston and Albany road. The "Adirondack," built at the Springfield shops of the Boston and Albany Railroad, and the "Brown" built at the Rhode Island Locomotive Works, are the engines which have been put on trial for a week, the test being to determine which machine can do its work with the least expense for fuel. The engine averages about fifteen miles an hour for the whole trip.

Engineer Sprague of Conway has begun the preliminary surveys for the proposed narrow-gauge railroad from Holyoke to run down the west side of the Connecticut river to Hartford. It is intended hereafter to run another and connecting line up the east side of the river to Turner's Falls, and crossing there, to run up Fall river to Wilmington, Vt., connecting there with the Green Mountain narrow-gauge railroad. The special design of the enterprise is to secure a cheap freight line from Turner's Falls and Holyoke to water communication at Hartford, and it is expected that the present rates of freight will be reduced at least one-half.

Miscellaneous Notes.

The saving of expense to Taunton, Mass., in water piping, compared with the cost a few years ago, is a large item. In 1872 iron was $55 per ton, and the pipes would have cost $70 per ton, at least. Now the piping is delivered at $35 per ton, or about 1¼ cents per pound. It will require about 3000 tons under the water contract, making a difference of over $150,000 in laying and completing this branch alone, compared with the expense four years ago.

Advertising is universal, and, newspaper advertising is the perfection of the art. All other methods of advertising have to depend more or less upon the publicity of newspaper mention for the full effect. More money and reputation has been acquired through newspaper advertising than by almost any other means except conquest. The instances are few where advertising has not paid in some measure, but the instances are to be seen on every hand where an imperfect knowledge of the business has hindered the full return which would have followed judicious and systematic advertising.

Three engineers, under the supervision of Mr. E. C. Clark, are now engaged in surveys for the proposed new main sewer in Boston. One is at Moon Island making surveys, another making observations with reference to the currents prevailing in the harbor by means of floats, while the third is employed in artesian borings to determine upon the feasibility of tunnelling the Neponset river. Mr. Clark, the engineer in charge, was resident engineer of the Detroit tunnel, and of the last tunnel under the city of Chicago. He has also been connected with sewer work at Chicago and in Philadelphia.

The water system of Dubuque is quite a novelty. In one of the bluffs a lead mining company met obstruction from water, and to obtain relief the bluff was tunneled, when it was found that a copious fountain had been struck which ran to waste for several years. But the water was most excellent, the supply exceedingly liberal and the head so elevated that the idea of utilizing it was seized by a company, the property purchased, and a system perfected which gives the cheapest and best water supply known in the country, furnishing the city for all purposes at an expense of $8000 per year. There is also a sufficient supply to be used for water power.

We learn from the Providence *Bulletin* that the Cornish pumping engine at Pettaconset seems to be fully justifying the anticipations of its projectors. For some days past, with the use of Cumberland coal, delivered at a cost of five and a half dollars, the engine has been quietly doing a duty of 95,000,000. All the indications so far are that as a permanent, reliable, economical pumping engine, it has probably no equal in the country. It is encouraging to learn in this connection that the experimental filter basin at the pumping station, which comes into use with the new engine, promises to afford all the water needed for the present supply, without further drawing direct from the river.

A telegram from Montreal says: "As stated yesterday, Aug. 8, the Premier proceeded with the harbor commissioners to Lake St. Peter to examine the work of deepening the channel of navigation now in progress on the lake and at various places between it and this port. Both Mr. Mackenzie and the commissioners were very well satisfied with what has been and is being done, and were particularly pleased and surprised by the superior facility and efficiency of the new plan of removing the ledge rock at Cape St. Charles by means of the toothed dredge. In some places the channel is being cut to the full depth of twenty-five feet to avoid going over the difficult work twice. The changes in the course of the channel seem to insure all the advantages anticipated.

Contractors' Intelligence.

It is understood that a party of eastern capitalists are about to establish a rolling mill, in or near St. Louis, for the manufacture of iron hoops and small rails for narrow-gauge railroads. The site for the new enterprise is expected to be located either in South St. Louis or East Carondelet.

Abiel Stevens, an old railroad contractor, died two weeks since at Amherst, N. H., at the age of seventy-two. He was a contractor on the Boston and Albany road, the Boston and Providence, the Central Railroad of New Jersey, the Troy and Greenfield, and other roads. He retired from active life several years ago.

The contract for the superstructure of the Milwaukee avenue viaduct in this city was awarded by the Board of Public Works to the American Bridge Company on the 10th inst., for $35,300.15. The viaduct spans the track of the Milwaukee & St. Paul, the Pittsburgh, Cincinnati & St. Louis, and the Danville & Vincennes Railways, at Desplaines street. The substructure is nearly completed.

A report has been widely circulated that the American Bridge Company, of this city, were about to throw up the contract for the Poughkeepsie bridge because, as was stated, some $25,000 was lacking of the subscription specified to be raised, before the company commenced operations. This proves on investigation to be entirely untrue as the company is at present forwarding material to begin construction and expect to put one or more piers in place before winter. The work is to be pushed with all practicable energy.

The Keystone Bridge Company has taken contracts for the following iron bridges on the Galveston, Harrisburg & San Antonio Road; Guadaloupe river, one span 258 feet, two spans 158 feet, one span 128 feet; Ciblo river, two spans 158 feet, two spans 88 feet; Salado river, two spans 128 feet, two spans 88 feet; Tio Geronimo, one span 128 feet; Tongo creek, one span 128 feet; Dietz creek, one span 88 feet. All to be completed this year. These will be the first iron railway bridges in Texas.

The Jackson (Miss.) *Times* notes the completion of the Pearl river bridge. The length of the bridge is one thousand and eleven feet, width thirty feet. There are twenty-three spans of the following dimensions: One eighty-one feet, two of fifty-two feet, twenty of twenty-nine feet, one of sixteen feet, and a circular approach of thirty feet. The lumber is all the best quality of heart pine. The covering of the main span is of clear cypress. All of the ironwork was made in Philadelphia. The channel spans are strongly anchored to solid built piers resting on well driven piling. The piles are driven through the quicksand a depth of eight feet to the clay foundation below. Major M. S. Hasie is the contractor.

Foreign Intelligence.

There are 771 kilometers (478 miles) of sewers in Paris, France.

British India in 1875 contained 6361 miles of railway from which the aggregate receipts were £7,388,323.

The Russian Technical Society has offered prizes for the best treatise on the management of steam engines and boilers.

The management of the Eastern Railway of France is directing its attention toward the introduction of iron sleepers upon portions of its system.

Greece, with a population of 1,458,000, has only six miles of railway. Java, with a population of 13,000,000, has 179 miles; Peru, with a population of 3,000,000, has about 1000 miles of road in operation.

Soundings recently taken in the bitter lakes on the Suez canal route show that the bed of salt at the bottom of these lakes is gradually dissolving. This result was anticipated by the projectors of the canal and will give increased depth to the lakes much to the benefit of navigation.

The deepest perpendicular mining shaft in the world is in Prizibram, Bohemia. It measures 3280 feet. The mine is for lead, and is supposed to have been worked 350 years. Greater depths have been reached in other places, but not in one perpendicular. A rock-salt mine near Berlin is 4175 feet deep, and a coal mine in Belgium is 3542. The deepest hole in the earth is the artesian well at Potsdam, Mo., 5500 feet.

It is said that the French metrical system of weights and measures is about to be introduced into Russia. The special committee who are sitting at St. Petersburg, at the headquarters of the Russian Imperial Technical society, have not only come to the conclusion that such an innovation would be useful, but have also emphatically declared that, if the French system is to be introduced, the present is the fitting moment. They think that the change ought to be accomplished within two years.

At the present time the exports of Egypt amount to about $60,000,000, annually, and the imports, $30,000,000. The present ruler has brought 350,000 acres of desert under cultivation. There are now in working order 113 navigable canals, which supply 720 smaller canals, and they again fill numberless water courses. There are also 30,000 water wheels, for irrigation purposes, worked by animals; 70,000 well sweeps, and 500 steam pumps. There are 1,100 miles of railway in operation, and four thousand miles of telegraph. Cairo has been recently lighted with gas, and the streets are paved. Altogether for an "effete civilization." Egypt is making great strides.

In ten years the screw has entirely replaced the paddle in transatlantic navigation, the weight of marine engines has diminished one-half, the steam pressure has quadrupled, and the consumption of coal has decreased two-thirds.

Eight miles of main and distributing pipes have already been laid in connection with the Danvers, Mass., water works. The reservoir, which is to be located on Hathorne hill, will hold 5,000,000 gallons, and is 230 feet above tide-water. Water will be pumped into the reservoir from the pond by an engine capable of raising 2,000,000 gallons in twenty-four hours. The works will probably be ready for use on the first of December.

The *Railroad Gazette* says: California wheat has to make a voyage of something like 13,000 miles to reach a market. Nearly all of it goes to Europe, and all that goes to Europe is taken around Cape Horn. This distance is something like three times that of the Northwestern grain districts from the European market; besides which must be reckoned the distance of the California wheat fields from the sea. One might think that this distance would prohibit shipments; but really it has comparatively little effect. The quotations for cargoes from San Francisco to Liverpool show rates from 16d. to 19d. per bushel—7d. to 10d. more than the rate from New York to Liverpool. Current rates from Chicago, ridiculously low as they are, will reduce this difference so that the cost from San Francisco to Liverpool is but 3d. to 6d. more than from Chicago to Liverpool. The San Francisco rate is something like 0.005 cent. per ton per mile.

Inferiority of German Manufactures.

German industrial circles are painfully excited by a competent judge declaring the manufactures of this country inferior to those of other civilized lands. This severe criticism has been recorded against German industry by Professor Reuleaux, director of a government technical school at Berlin, and chief commissioner to the Centennial Exhibition at Philadelphia. This well-known gentleman, in a letter to the editor of the Berlin National Zeitung, condenses his views into three condemnatory sentences, one more crushing than the other.

The first conclusion at which he has arrived from a careful inspection of the German department at Philadelphia is that the main object of the German Manufacturers is to produce an article which shall be cheap and nasty. His second observation purports that German manufacturers find it easy to succeed in the line they have chosen for themselves, considering that the men they employ are deficient in skill and taste. As a third and crowning remark upon the character of the German articles displayed at the centenary show, the professor finds himself obliged to add that the German nation seem to be steeped in utter servility, so great is the number of Bismark statues, Red Princes and other heroes of the war, in every conceivable material, from gilt bronze down to common soap. It is easy to imagine the impression produced by such a sentence pronounced in uncompromising language by the person officially sent out to report upon the latest competitive display of the world's manufacturers. Most papers have discussed the letter of the out-spoken witness. The excitement getting more intense as it spreads to wider circles, the letter is sure to produce consequences in the shape of legislative measures. The most remarkable feature of the debate called forth is the approval of the more important observations uttered by the censorious critic. I do not remember seeing it denied in any paper that German goods nowadays are recommended by cheapness, not by quality, and that the careful finish which used to distinguish the articles of this country is no longer what it has been.—*London Times.*

The Real and Apparent Value of Machine Effect.

BY J. RICHARDS.

There is often so great a difference between the apparent and real advantages resulting from the employment of machines, that this alone, if other reasons were wanting, is enough to prove the value of critical observation, and the necessity of dividing results into the two classes of mechanical and economical. An example will serve to show how erroneous impressions may sometimes be formed from noting only the apparent value of machine effect.

Among the various kinds of work, once performed by hand and now very generally done by motive power, is the driving of piles, and there are but few who at first thought, and without investigation will not conclude, that pile driving is one of those cases wherein motive power has with the greatest advantage supplanted hand work. The act of lifting up a weight to be let fall upon the end of a pile certainly is among those low duties which may be called drudgery when performed by hand. The ram guides itself, even the length of its movement is not determined by those who raise it. The work is wholly without skill, and can be equally well performed by horses or men. In such work we see the direct application of power, no complicated machinery intervenes to break the connexion between the motor and the work, consequently when steam power is employed, the mind of an observer at once is carried into an estimate of how many men would be required for the same duty. The ram falls with tremendous force, and this force being expended in a very short distance, gives an exaggerated impression of what is really done; in fact, the operation seems to involve a vast power far beyond the scope of human effort.

This is the common impression of pile driving even among those who have more than a superficial knowledge of such operations, an impression which is much heightened by witnessing one of the American gunpowder pile-drivers, where a report equal to that of a six-pounder accompanies each blow.

Now the fact is, notwithstanding this apparent gain, pile driving is not one of those operations wherein the employment of steam power and machinery has so far exceeded hand performance. It is even questionable when we come to scrutinize the various conditions attending on this kind of work, whether pile driving cannot in many cases be performed quite as cheaply by hand as it can by steam power.

During the summer of 1874 the writer visited some works being erected along the Gotha river in Sweden, among others a bridge which was being built at Gothenberg, to connect the city with the "Hissingen side." This bridge, a plain iron structure, was supported on piles, as all works are about Gothenberg. At the time of the visit the pile driving operations were going on with great speed, and were performed wholly by hand. This mode of driving of course created some surprise, especially as Sweden has an advanced place in the application of motive power to supplant labor. It was found upon inquiry, however, that steam pile driving had been tried and was abandoned as too expensive and too much trouble; that the hand driving contractors had, in fact, through legitimate competition, driven out steam power, and that no one had for several years employed it.

To one accustomed to think of hand pile driving as of something like a connexion with road wagons between London and Edinburgh, this statement of course awakened some interest, and the investigations, or deductions rather, which resulted, will be set down here in illustration of the subject being treated. The first thought was naturally of the relative value of machin-

ery, fuel, and labor, but these were found to bear much the same relation as in England; labor being worth about four and one-half "kroner" (Swedish crown 13½-d.) per day, and coals as cheap as in London. The alluvial deposit which constitutes the only land about the mouth of the "Gota Elf" is, it is true, soft, and offers a minimum of resistance to driving; but the circumstances are not much different from those which generally exist about the delta of rivers where much piling is necessary. The query therefore, became, "What are the economical conditions of pile driving as a mechanical operation that men should compete with a steam engine?"

The mode of operating, it should be explained, corresponds to what is technically called "whipping," formerly practised in unloading coals from vessels and sometimes yet to be seen at the London docks. A number of men acting in concert each having a rope attached to the main one, "whip up" the drop much as they would toss a weight into the air. The ram being tolerably heavy, and falling but a short distance, meets the pile at a low velocity, and consequently without that waste of power which is so common in pile driving. The operation was, in fact, something like that of the gunpowder method by which the pile is "pushed" instead of being "knocked" into the earth.

Let it be assumed that 1000 piles are to be driven with an average penetration, and under circumstances the same as at Gothenberg, that is, a part of them on land and a part in the water, and that this number is considerable enough to warrant the adoption of the most economical means of driving. The operation will comprise various details, such as providing and erecting what may be called plant, including barges, platforms, derricks, ropes, and so on. These things have to be assembled, transported to the ground, and set up.

When the work is begun, at least one half is devoted to what may be called adjustment, that is, moving derricks after driving each pile, bringing the piles into position, and setting them, sawing off, measuring positions, and so on. The proportion of time occupied by this work of adjustment will of course depend on how rapidly driving is done, but in any case will constitute about one-half. To employ a steam engine to raise the ram, at least four men will be required with each derrick, or to add the expense of fuel, oil, wear and risk of machinery, with something for special skill required in the care and management of the engine, and then call the sum labor, it will equal six men for each derrick. Every movement from raising a pile until it is driven involves a concert of action between the men and the machinery. Every stop and start calls for signals, waiting to see if all is ready, and, worse than all, it leaves the men for a considerable portion of the time unoccupied, farther than to watch the rise and descent of the ram.

The steam engine has nothing to do with what was called adjustment constituting one-half the work, that half which involves care and judgment. It merely hoists the pile to be set, and then raises the ram; all besides is handwork. The economical advantage gained by a steam engine lies therefore in what is gained over employing enough men to raise the piles and the ram without the engine. Twelve strong men can operate a ram, and while the blows given are inferior in force, they can be from six to ten times as many in number. This extra labor would at four and one-half Swedish crowns per diem for each man, amount to 30s., but even this small sum is not to be balanced equally against what would be gained by employing a steam engine. The labor of driving as practised in the case referred to was not so severe but that the men could at once go on to set a new pile when one had been driven, and it need hardly be explained how much was gained in raising and setting piles, moving derricks, and platforms, with other adjusting work, by having twelve men instead of six to peform it.

Besides, as in the case alluded to, there is often much to be gained by a speedy performance of the work. In Sweden the summers are short, and such undertakings if completed in one season, must be carried on rapidly. To multiply the work in hand driving is an easy matter. A new derrick with men to work it is soon added, but if a steam engine with its details was included, the case would be different.

A superficial examination in an isolated case, and one where many minor points might not be understood by a stranger, does not, of course, furnish data for a general rule, but one thing is certain, that hand pile driving at Gothenberg is less expensive than steam driving, and where the same conditions exist the same rule will hold good. The fact is that the part performed by a steam engine in pile driving instead of constituting the main part, as it seems to be, is really a secondary one, and without looking into the matter from both a mechanical and economical point of view, it would be very easy to form false estimates.

It is not hard to imagine circumstances under which a person who had a contract of piling to perform would send out steam engines for the work, to a place where a ton of coal would cost more than its mechanical equivalent in hand labor. It is not likely that a skilled engineer, or an experienced contractor would do this, yet things not less mistaken have been done and will no doubt continue to be. The profit with which motive power can be employed in supplanting hand labor seems in such cases as that just cited to depend more upon what was called adjustment, than any other condition. If the power can be applied continually in one place and under uniform circumstances as to time and amount, the economic gain is such as to leave hand labor out of the question. Pile driving is generally the reverse of all this, the work is continually being shifted, and the application of power is very irregular both as to intervals and degree.

An example of the opposite kind is in raising the material for building when it is all received and raised at one point, so that the plant can remain fixed during the whole time. In such cases the real often exceeds the apparent gain, and so well have builders and contractors come to understand what may be called the economics of steam handling, that one would look for a long time, in England at least, for a mistaken use of machinery. In America, where fuel is cheaper and labor more expensive than here, one may often see cases where steam power would supplant hand labor and effect a saving. A single one may be mentioned. At the docks in Philadelphia, there was two years ago no handling machinery operated by power, in fact, but little of any kind, and the principal problem in shipping heavy machinery was not in transporting it to the docks so much as in getting it oft trucks and into vessels. This was no doubt, as in New York, partly owing to a contemplated change and improvement of the docks and piers, but nevertheless is open to an inference that the economic conditions had not been inquired into.

The apparent value of machine effect is much stronger in the case of concentrating or multiplying power than when machines are directed to the attainment of true movement or rapid movement. To see the work of fifty men performed by machinery for raising or moving loads makes a very different impression from witnessing a cotton gin doing what may be considered an equal amount of work. This is for two reasons; one is a dynamic result and admits of ready comparison with hand labor; the mental measure applied is to physical force alone. In the other case, that of a cotton gin, the comparison is made with human dexterity or rapidity of movement, a matter much more difficult to understand than simple force.

A workman could, with a hand card constructed like the saws of a gin, pull the fibre from the seed much in the same manner that the operation is performed by a gin cylinder, but his hands could not move a fiftieth part so fast, nor in so exact a manner, although he might at the same time be able to exert an amount of power equal to that required to drive a gin. When cotton was cleaned by hand, or at the time when power gins first came into use, the economic value of their performance was no doubt apparent, and as readily understood as the advantage of a steam engine in lifting loads now is, but, as remarked in a former place, hand ginning has passed away and a new standard has to be employed to measure effect.

Such problems as the difference between the real and apparent effect produced by machine processes may seem simple and scarce worth attention when there are so many things admitting of exact instead of what must in some respects seem to be speculative treatment, but such problems have a much more extended influence in the conduct of the affairs of a manufacturing country than is generally supposed. If we were aware of the industries and enterprises which have their origin in schemes wholly unqualified by exact knowledge or even by careful observation, it would, no doubt, be a matter of surprise to most of us. The element of chance must ever form a considerable one among the incentives which call out enterprise, but there is enough of this left in manufacturing by reason of mechanical improvements without including an uncertainty of such economical results as are deducible by the exercise of ordinary reasoning power.

The development of manufactures has no doubt been mainly experimental, but not wholly so, and every year is adding rapidly to the confidence felt in such economical principles as are known to apply to labor, capital, and machine processes. The engineering profession cannot be wholly confined to the scientific and mechanical details of structures, machines, and processes, it must also include the economical part; not as opinions and conjecture, but founded as far as possible upon exact data in the same manner that various mechanical problems have been so successfully treated.—*Engineering.*

Improving the Mississippi.

THE following extract from the Boston *Advertiser* was alluded to last week but failed to appear in our paper as was intended:

Captain Eads, who has been in New York this week, has matured a plan for the further improvement of the entrance to the South Pass of the Mississippi river, and surveys have been made to perfect it. By this plan the current is to be confined to a narrower space than it now occupies, by means of wing-dams and dykes, which will greatly increase its velocity as it enters the jetties, scouring away the bar which extends from 2000 feet to about 300 feet within the Pass, and on which at present there is a variable depth of between 17 and 20 feet. Captain Eads feels confident that a permanent channel can be secured and maintained through this bar, if its entire removal cannot be accomplished, by placing these wing-dams, two on each side of the river, and jutting from its bank, above the jetties. The upper pair of these dams will be 3000 feet above the upper end of the jetty work, the one from the right bank jutting 1200 feet into the river, and the one from the left 1400 feet, leaving an open way for the passage of the water of 5000 feet. The lower pass will be only 200 feet above the jetties. The right dam will be 600 feet long, but does not rest upon any base in the way of bank or dyke; while the left one will extend at an angle of 90 degrees from a dyke already built and known as the east dyke. The latter extends from a point 800 feet below the head of the South Pass to 1400 feet above it. The passage between the last pair of dams will be 800 feet, which is the average width of South Pass, and thus the body of water which naturally seeks the latter is narrowed and forced with greater velocity between the jetty walls. The construction of these dams will be begun as soon as the surveys necessary to the work are completed.

The latest news from the jetties shows a degree of progress which, it is thought, proves, from the constant deepening of the water in the South Pass, that they will eventually be perfectly successful. Grand Bayou has been closed, and since that was done the speed of the current has increased to such a degree that it has removed by its force a vast body of earth. Constant soundings, taken from day to day by those on the work, prove that the channel is becoming a straighter, wider and deeper one, having an average depth of 20 feet almost through its entire length. The only places where this depth is not found are at either end of the pass—within 300 feet of its upper end, and within 1000 feet of the sea terminus of the jetties; and the least depth discovered at these points has been 19 feet, and that only for a distance of 75 feet up and down the stream. One of the arguments put forth by the opponents of this work has been that a new bar would form at the mouth of the jetties, the latter would have to be prolonged, another bar would form, and so on indefinitely. On the contrary it has been proved, it is asserted, that a sand or "mud lump," which formerly existed at the mouth of the pass, has been cut in two by the current, and is gradually washing away into the deep waters of the Gulf, a channel now passing directly through it which is more than 100 feet wide and 20½ feet deep, daily widening and deepening.

REPORTED LOW PASS AT THE ISTHMUS OF DARIEN.

In Nos. 28, 31 and 33 we alluded to the revival of interest in the proposed inter-oceanic canal across the Isthmus. In our last issue, after giving the route proposed by Mr. Gorgoza we expressed the opinion that this route would result in disappointment. We propose now to give our reasons for this opinion.

In 1870 and '71 Commander Selfridge made a survey of all the routes on the Isthmus which appear at all possible for a canal, and his report was issued in 1874. A review of this report would be interesting at the present time had we the space and time, and to it we refer those who desire fuller information.

A careful study of a good map of the Isthmus, its mountains and rivers, will quickly lead one to the conclusion that it would be fruitless to look for a low pass except in the following locations of the present Panama route; from some point on the Gulf of San Blas to the valley of the Chepo (or Bayamo) River; from some point on Caledonia Bay [the route of Dr. Cullen] to the valleys of the Chucunaqua and Tuyra rivers, to the Bay of San Miguel; by the Atrato River to the plane drained by the Cacarica and Parancita rivers via., Cacarica Pass to the valley drained by the Tuyra River to the Bay of San Miguel, [the route advocated by Hellert, Gorgoza and Lacharme]; and lastly from some point on the Atrato River where it approaches the Pacific Ocean. Possibly there might also be an additional route west of the Panama Railway. Of these routes, all of which have the advantage to a greater or less extent of natural harbors, on a more attentive study of surface configuration and water courses one would undoubtedly select the Panama route, the route by the Rio Atrato; Cacarica Pass and the Rio Tuyra River as the ones possessing the lowest divides and the most feasible for a through cut, unless possibly one might select a route farther up the Rio Atrato, balancing a probably higher summit. These routes have all been surveyed and the reports afford the means of testing the conclusions. The Panama Railway line is certainly the most feasible for a through cut, presenting as it does, a summit of only 22 ft. elevation, probably the lowest line between North and South America; but its harbors are not as good as might be desired. The San Blas route, although only 27 miles from ship navigation to ship navigation, would require a ship tunnel ten miles long for a canal at tide level, and one seven miles long for a summit 372 ft. high. It is utterly impracticable as compared with other routes.

The Caledonia Bay route has a summit of 1,000 ft., is longer than the San Blas and, if possible, more impracticable. The route by Cacarica Pass we will discuss shortly. The route recommended by Commander Selfridge was from the Rio Atrato, 150 miles from its mouth and needing no improvement, up the valley of the Rio Napipi, to the divide and thence to Chiri-Chiri Bay on the Pacific, a distance of 28 miles, of which three is ship tunnel, estimated to cost from $50,000,000 to $100,000,000 according to the plan adopted. The canal was to have 25 ft. of water and be 50 ft. wide on bottom in earth, and 60 ft. in rock; on one estimate, to have 20 locks, 427x54 ft. with total lockage of 202 ft., and on another, three locks with a lockage of 38 ft.

The other line by Cacarica Pass, probably the second lowest on the Isthmus, is the one now urged by Senor Gorgoza before the Colombian government and for which he has obtained the contract for a survey and in the event of a practicable route being discovered, the contract for the building of a canal or railway.

On reference to the report we find that the same gentleman then advocated the Cacarica Pass as strongly as he does at present, making equally as unwarranted assertions in regard to its extreme lowness as now, and which were entirely dissipated by the survey of Commander Selfridge. We suspect that the gentleman has some ulterior object in view, and it is our opinion that the survey will be valueless, and as the Colombian government has again been attacked by its chronic disease, civil war, any assistance from that quarter may be considered out of the question.

Starting from Columbia Bay (or Gulf of Darien), one of the finest harbors on the Atlantic coast, we enter the Uraba mouth of the Rio Atrato, and follow it about 22 miles to its junction with the Rio Atrato, and thence by this river 19 miles, to the mouth of the Cacarica River where the proposed canal is to commence. There is a bar at the Uraba mouth, with 7 o8 ft. for water, which can be improved at small expense, and the river is navigable for the largest vessels. From the Rio Atrato the line would follow the valley of the Cacarica or the Peranchita to Cacarica Pass and thence either by the valley of the Mono and Cue' or by the Paya, tributaries of the Tuyra, and down this latter river to Darien Harbor and the Gulf of San Miguel, the finest harbor of the Pacific. In fact the most that can be said of this route is in reference to its harbors. Lines of levels were carried from both oceans to the summit near the head of the Cue' River and carried along the summit nearly to Cacarica Pass, but through the pass no line has been carried, a circumstance greatly to be deplored. This was due to the rainy season, which absolutely stopped farther progress. But so many points were taken in the valleys on either side, that any thought of a low pass must be abandoned.

For the benefit of future explorers Commander Selfridge says, "that the lowest line in this region will be found to follow the Tuyra to the Cue', up the latter to its first tributary on its right bank, the river Mono; it will then follow the Mono to its sources, which will bring the line very near the lowest point of the divide known as the Cacarica Pass. Then it should follow the course of a river, name unknown, that empties into the Peranchita at its left bank, above the junction of the latter with the Rayo."

Following up the Tuyra river its elevation at the mouth of the Cupe' is 48 ft., at mouth of Paya 144 ft., at mouth of Cue' 170 ft., at mouth of Mono on Cue', 233 ft., and at Fork of Cue' 513 ft. Paya village on the Paya branch of the Tuyra is 270 ft. high and as a line was carried between the mouth of the Mono River and Paya village, covering all the approaches to the Pass, certainly no Pass less than 270 ft. could have existed without being discovered. Although no line was carried to Cacarica Pass, Commander Selfridge made a reconnaisance in person, and took the height by barometer, and making the most favorable deductions the hight could not be less than 410 ft., and probably no pass of lower hight exists in this region. The ground on the Atrato side slopes suddenly from the summit, and is a level plain thence to the Atrato. On the Pacific slope it is broken up into numerous hills as far as Santa Maria.

The length of canal required on this route would be 55 miles, and the Pacific end would be 5 miles below Santa Maria. Fixing the summit level at 160 ft., there would be a through cut of 15 to 18 miles and a total excavation for the whole canal of 46,000,000 yards of earth, and 62,000,000 of rock, with a total cost of something like $250,000,000. From the mouth of the proposed canal it is about 40 miles to the Bay of San Miguel, making the whole route 136 miles, with 55 of canal, and a total lockage of 312 ft. It is unnecessary to say that this route bears no comparison with the Napipi route of a total length of 178 miles, of which 28 miles are canal, and less lockage and one-fourth the estimated cost. Neither does it bear any comparison with the route by the Panama Railway which has the advantage of lying right at the points most needed, but with the disadvantage of poor harbors. Since the works that have been executed at Port Said, this is not a consideration of as great weight as formerly and the possibility of making a through cut at tide level, which is impracticable in any other route, would seem to warrant a closer investigation of its merits. From the proximity of the railway to the probable line, a minute survey could be made at comparatively small expense, and the wonder is that such a survey has not been made, at least we have not heard of it. We think the objection of Commander Selfridge to the low bottom lands of the Chagres River one of the strongest points in its favor. Certainly he should not expect to find the site for a through cut on high ground, (out of the swamps which of course are fever breeders, especially in tropical climates) as his constant reference to the necessity of avoiding all swampy or low ground woutd lead one to imply.

The objection to large volume of water can we think be readily met by engineering skill. He certainly could not expect to find a deep valley cutting the Isthmus nearly in two at a low level, without a large volume of water running through it. Our study of the mountain ranges and the rivers of Selfridge's map has convinced us that, all things considered, the Panama is the most favorable route, although its expense would probably exceed somewhat the Rio Napipi. We would advocate its immediate and minute examination.

CLIMATIC CHANGES.

Australia has always been in the nature of a quandary to most geologists and naturalists. Whereas nature seems to have, to a great extent, completed her great works in other lands and fitted them for the habitation of man, here she seems to be in the midst of her labors, discovered, as it were, in her metamorphosis from a region of barren interior devoid of rivers, and with a low order of animal and plant life, to one more in keeping with her sister continents. Lakes and rivers that scarcely had an existence on its discovery, have now assumed formidable proportions and the face of the country is becoming more fertile, the rainfall is increasing, and the sea coast belt of habitable territory is extending inland. Lake George some twenty-four years since had no existence and at present it is twenty-four miles long and seven wide and growing. Lake Bathurst is another example on a smaller scale.

The floods in the rivers have greatly increased and probably the mean rainfall. The reasons for these climatic changes are not clear, some attributing it to the clearing away of the forests and the cultivation of the land, and others assert that the clearing away of forest has the opposite effect. No doubt in a wooded country the floods are diminished but their effect on precipitation is not clear. In our own country on the western plains, changes no less remarkable are occurring. Throughout Kansas and Nebraska, as the area of cultivated land pushes westward the boundary of barren lands also pushes ahead. Whether this be due to cultivation of the soil or to climatic changes possibly involving the continent it is at present impossible to tell. In Texas, across the *L'lano Estacado*, which was once a barren red sand or loam, fertile in itself, cactus, patches of grass and occasional *chapparel* are now beginning to cover the face of the land, and what was once a desert region in another century may become a fine grazing country if not also tillable. The basin of Great Salt Lake is blessed with an increased rainfall and for several years the surface of the lake has risen at the rate of ten inches per annum. Once it was an inland sea 970 ft. higher than it is to-day, covering also Servier Lake Basin and having an outlet northward by the Columbia River. So the changes that we witness may be periodic and the cause farther to seek than in increased area of cultivation, this extension of tillable area being rather in a nature of an effect which may at the same time supplement and intensify the results of the original cause. At any rate our public domain west of the One Hundredth Meridian has much increased in value since the first exploring parties traversed it, and these changes are so rapid as to be noted in the life-time of individuals. It would be interesting to know what are the causes and whether these changes are permanent, periodic, or entirely sporadic.

MR. FLEMING has written a history of the Intercolonial Railway of Canada which was so recently completed. Like all true Canadians he expresses regret at the "blunder" of the Ashburton Treaty by which Maine was unjustly given to the United States. This fact doubled the length of line necessary to bind the provinces into one great confederation, which we are assured was a proven political and military necessity. He enlarges on the results which are to follow the binding of the provinces together by daily communication, through what otherwise is practically a wilderness separating their interests as completely as an impassible mountain chain. Probably in a financial sense the road cannot be considered a paying investment, although it gives to Canada her only seaboard outlet open at all times of the year. Mr. Fleming gives some interesting figures which show that the line was by no means an easy or cheap one to construct. The masonry amounted to 200,000 yds., and the excavation to 16,000,000 yds. of which 10 per cent. was rock. Comparing the different divisions the lowest average excavation per mile was 13,665 and the highest 81,996 yds. Along the whole line the average excavation was 32,210 yds. per

mile, and the masonry 401 yds. per mile. The capital account shows an expenditure for all purposes including branch lines and rolling stock of $21,569,136.79 or about $43,000 per mile.

LETTING OF THE CONTRACT FOR COOK COUNTY COURT HOUSE STONE.

It will be remembered that in our issue of Aug. 12th, we gave an analysis of the bids for the stone for the Court House. At that time the committee of the County Commissioners had accepted Walker's bid at $695,000, but owing to the general indignation of the community and of the contractors they moved to reconsider the bids and hear more testimony. In the mean time those commissioners who were in favor of Walker, again visited the Lemont quarries, and in the absence of the opposition commissioners, who knew nothing of the contemplated inspection, their conclusion that Walker's quarry was the only one which could furnish stone of sufficient thicknes, was remarkably unanimous. So much opposition to Walker having been awakened that it was doubtful if his bid would be accepted before the full board, a new deal was had in which the bid of Wm. McNeil & Son, which had not been considered previously at all, was selected as the most eligible, Mr. Walker having signified his *willingness* to be one of his bondsmen and also to furnish the stone from his quarry, he giving a mortgage on the same.

A great many people still denounced this virtuous act of the board as but a new shift in which the same parties were involved but under a new firm name. Communications were received from all sides denouncing McNeil & Son as irresponsible parties, and the Stone-cutters Union, in particular, protested that "they are incompetent for the work financially and mechanically," being "unknown as stone-cutters" etc., implying plainly that the contractor should be a man who understands the business which he proposes to engage in, a consideration quite unheard of, of late, in Chicago lettings.

Finally on Thursday the subject was brought before the full board and the bid of McNeil & Son accepted at $540,000 which although not the lowest limestone bid, is within $5,000 of the lowest. Had the bid of McNeil & Son not been accepted, as seemed likely at one time, rather than abandon their untenable position, —*i. e.*, the decision in the first place that limestone was the only proper stone for the Court House—Bedford limestone would have been accepted, which on the whole is handsomer and better, although it would have had the objection of a certain select coterie of men voting for it solidly as was the case on every proposition advanced from the beginning to the end of this whole miserable business.

It is likely that this contract will never be consummated. The city, who is to occupy half the building, will shortly begin to open its eyes and enter a protest, and interested citizens will enjoin proceedings, and the final letting of the stone contract will go over until a new board is elected. In the mean time the city will have completed its agreement with the county by which the latter shall build the city portion of the building also, and the foundations can be laid and carried up on the city portion of the building without loss of time, preparatory to carrying the whole building up together next spring. Probably the city will also have a committee appointed to confer with the county on the selection of the stone, and it is possible that ultimately some better stone for this purpose than Lemont will be selected, and the contract awarded within at least $100,000 of the lowest bid.

MR. H. D. GARVEY, owner of the Watob Granite Quarries, near St. Paul, Minn., writes to the Cook County Commissioners that he will donate all the stone required in the erection of the Court House. The stone from these quarries is a very fine gray granite and the supply is inexhaustible. He makes this offer in order to introduce it into this market. The cost of quarrying would be about 15 cts. per cubic foot and of transportation, about 20 cts. per cubic foot, or 35 cts. delivered in Chicago in the rough. As Thomas Cumming's bid for Bedford limestone was 60 cts. per cu. ft. in the rough, and Edwin Walker's, for Lemont stone, 87 cts., here is an excellent opportunity to obtain the most superior stone and at a very moderate cost.

THE cables of the Brooklyn Bridge will be four in number, each cable 15½ in. in diameter and composed of 6,300 steel wires of 14 ft. to the lb., giving a weight of 450 lbs. per lineal ft. of cable. The distance between the anchorages is 3,500 ft. and, allowing for deflection, the total weight of the cables will be about 6,800,000 or 3,400 tons, or about a ton per lineal foot of bridge for the cables alone. The roadway is placed at 135 ft. and the top of the towers at 275 ft. above mean tide. The saddles on the top of the towers on which the cables ride will weigh 13 tons each, the weight which they are to carry, or the weight of bridge between the anchorages, being estimated at 10,000 tons. The original estimate of cost was $11,500,000 of which nearly $6,000,000 was expended up to the beginning of the year. It is now thought that $13,000,000 will complete the structure. These estimates of course include land damages which amount to a considerable sum, as the approaches run back half a mile in New York and one-third of a mile in Brooklyn.

The Engineering and Mining Journal has come out with an editorial on "Premature Degrees" taking essentially the same ground as was taken in our editorials of July 15 and 29. We are also glad to notice that other journals are interesting themselves in the subject, and we hope that it will be so kept before our societies that they will see the necessity of early action. We are glad to learn that the subject is again likely to come up at the October meeting of the Mining Institute and we hope the conservatism of the American Society of Civil Engineers will not prevent their hearty co-operation. The subject is far too important and involves too directly the *esprit* of the profession to be allowed to pass by default. We most fully accord with the spirit of the article alluded to.

STILL they come! John W. Nystrom in his recent essay on the Metric System says that while his pages were in press, "information was received to the effect "that the SWEDISH Parliament has passed a law to "adopt the Metric System. About three years ago, "the Motala Iron Works in Sweden, adopted the Me-"tric System exclusively for all locomotive work. The "Medical Profession of Sweden has used the Metric "System for many years." Visitors at the Centennial Exhibition at Philadelphia remember with pleasure the magnificent display of the Motala Iron and Steel Works Company near the northwesterly corner of the Main Building.—(Communicated).

WE receive the following query from Waterloo Ill.: "State law in regard to two center corners in sections on North and West boundary of a township, and how would you divide for example, section 6."

Establish the quarter corners from the chaining on the north and west sides of the north and west section lines, and set ¼ corners for section 6 by measuring off the "jogs" as shown by the figures on the Gov't. plats. In the present case no "jogs" are shown and none are intended; if the quarter section corners are missing and cannot be established by evidence, divide *pro rata* the distances as given on the south and east sides of the north and west lines and set the quarter corners. To find the center of the section, divide *pro rata* the measurement of the east line, and on the south line the ¼ corner is midway; the intersection of the straight lines run between the opposite and corresponding corners thus found will be the center of the section required [Ed.]

TO ARCHITECTS.

HOUSTON, Texas, Aug. 16, 1876.

Editor of Engineering News,

Our City Hall was recently destroyed by fire. We have now arranged with the Insurance Cos. and expect to put up a new building. What would full plans and specifications cost, in case a ground plan and some sketches of the old, and of the proposed new building were sent. Architecture of this character is not in my line, and architects who have tried to make a living here have failed to do so.

P. Chitty, City Engineer.

(We leave the above to be answered by such of our readers as consider themselves competent to do so.—Ed.)

Editor Engineering News,

Can you refer me to an ink that can be used on mounted drawing paper, that is not liable to be eat up and spread by flies. We have had many good plans spoiled in this way and are compelled to leave them open as little as possible. Both Japan and India ink seem to be liable. By answering you will greatly oblige,

Yours respectfully,

Jos. H. Young.

Office of Surveyor of 12th District, Philadelphia, 4043 Locust st.

The Social Status of Civil Engineers.

On another page will be found a letter from a correspondent in which an effort is made to define accurately the profession of civil engineering. As there seems to be a great deal of ambiguity about the meaning of the term, and as to the scope of the duties of a civil engineer, we will devote a little space to the discussion of the subject.

Doubtless in its *first* meaning the word engineer, or the word from which it was derived, was applied to persons in charge of the construction or management of engines of war; because a state of warfare always preceded civilization. When civil works were constructed, the persons in charge of them were called "civil engineers" to distinguish them from military engineers. Now, to quote from Herbert Spencer: "An aboriginal name, applied indiscriminately to each of an extensive and ill-defined class of things or actions, presently undergoes modifications by which the chief divisions of the class are expressed." Now this modification occurred when it was necessary to distinguish civil from military engineers. But to quote from the same author again: "These several names springing from the primitive root, themselves become the parents of other names still further modified." Thus all language has gone and is still going through a process of evolution, or a transformation of the "homogeneous" into the "heterogeneous," as the scientific men state it. During the last thirty years, and since some of the definitions quoted by our correspondent were written, this second stage of evolution in the art of engineering has been developed so that the old classification into military and civil is not adequate, and, by common usage, the term civil engineering is applied, as Webster states it, to "the construction of *fixed* public works." We also have mechanical engineers, mining engineers, gas engineers and, lately, sanitary engineers, and the present subdivisions of labor will undoubtedly make necessary still further subdivisions and terms to designate them.

The idea of our correspondent seems to be that the term civil engineer is generic, and comprehends all the species of engineers engaged on work which is not military. In reply to this, common usage may be quoted and it may, we believe, be safely stated that if the question were asked whether our correspondent was a civil or mechanical engineer, not one person in ten, at all conversant about such matters, would for a moment be in doubt about the meaning of the inquiry; but it would at once be understood to mean whether he has been engaged in the construction of fixed works, such as rail roads, docks, etc., or in designing and constructing machines.

It is also a fair presumption that the author of one of the two dictionaries which are accepted as authority in this country would have some definite knowledge of the *modern* usage of such a term as civil engineer. At one time, undoubtedly, as Worcester says, the term civil engineering included the art of forming or the construction "of machinery for all purposes;" but owing to the process of evolution, both in the art and the science of engineering and the language which represents it, the term civil engineering, as Webster says, "refers, according to *modern usage*, strictly to the construction of fixed works."

In further evidence of this, it may be stated that Mahan's treatise on civil engineering treats of the following subjects, which are the heads of the different chapters "Building Materials, Masonry, Framing, Bridges, Roads, Railways, Canals, Rivers and Sea-coast Improvements." Rankine's treatise on the same subject has the following headings for its chapters: Engineering Surveys, Earthwork, Foundations, Masonry, Carpentry, Metal Work, Roads, Railways, Canals, Rivers, Water-works, Harbors, etc."

In the introduction to the Elementary Treatise on Civil Engineering, by Henry Law, published in the old Weale series, a synopsis is given of the science of civil engineering which is too long to copy, but in which there is no reference to the construction of anything excepting fixed works, and he speaks of machines only as "machines *employed* in engineering." Trautwine's "Civil Engineer's Pocket-Book" also refers only to the construction of fixed works. The authors of these books, which are accepted as standard treatises on civil engineering, have ignored what has lately been called "dynamical engineering" entirely, showing that they did not consider that it was comprised under the titles of their books, or, in other words, that dynamical engineering was not civil engineering as the term is understood in modern usage.

In the Sheffield Scientific School there are professors of both civil and mechanical engineering, and in the programme of studies given in their annual catalogue they say "students are received who desire to qualify themselves for such professions and occupations as the following," among which are given:

"Civil Engineers—with reference to the construction of roads and bridges, aqueducts, reservoirs, drainage systems and public works in general.

"Mechanical Engineers—with reference to the superintendence of manufactories, the invention and construction of machinery, the application of steam, etc."

In the School of Mines of Columbia College there are two distinct courses, one of civil engineering and the other of mining engineering, and a different degree is conferred for each, although in this case the professorship of both civil and mining engineering is held by the same person.

In the Massachusetts Institute of Technology there are separate courses for civil, for mining and for mechanical engineering, and professors of each. The same thing is true in the Department of Science of the University of Pennsylvania, and also in Cornell University.

This shows conclusively, we think, that those who teach civil engineering, and those who have written the standard treatises on this subject understand civil engineering to be quite distinct from other kinds of engineering, and not in any sense a generic term which includes all the other branches of engineering excepting military.

It may be thought that this is a dispute merely about the meaning of words, which in one sense is true; but it is because the words themselves represent an erroneous idea, which we believe sometimes leads to evil results, that it seems important that the meaning of the words should be made more precise. The error referred to is expressed in an address made by a civil engineer at a meeting of the Society with that title, in which he spoke "of the American Society of—not merely hydraulic, not merely mechanical, not merely railroad or topographical or bridge engineers, but of that which includes all these—of Civil Engineers."

Now this means, either that all these classes are civil engineers as distinguished from military engineers—a meaning of the word which has passed out of use—or else that a civil engineer is a hydraulic, a mechanical, a railroad, a topographical and a bridge engineer all in one. Our protest is against the assumption that a civil engineer is *all kinds* of an engineer, and competent to direct and give advice about all sorts of engineering work not military; whereas mechanical, mining, sanitary and other engineers' duties and knowledge confine them to the comparatively narrow field which is their specialty. It is because some civil engineers assume an attitude of superiority that we feel disposed to question the meaning of their title and the extent of the knowledge which it covers.

There can be no reason whatsoever why a man who knows how to build a dam, locate a railroad or drain a city should therefore know how to design a marine engine or superintend the working of a coal mine. Because an engineer knows all about hydraulic cement, it does not follow that he can design the strongest arrangement of rivets for the seam of a boiler. He might be competent to build the best kind of a masonry bridge, and yet be utterly imbecile in the construction of iron bridges. A man might have the eye of an eagle, be as shrewd as a fox and correct as mathematics in locating a railroad, and yet do nothing but blunder if he undertook to design a compound engine to work steam with the highest economy. Engineering art and science are now so extended, involve such vast and varied fields of knowledge and experience, that no human being can hope to become thorough master of more than one or two branches. It is admitted that, as a class, what are called civil engineers are generally more cultivated and perhaps belong to a higher social plane than the representative of other branches of engineering, but that a person whose training and experience have been in the construction of fixed works either acquires or requires any wider range of knowledge, any clearer apprehension of facts or comprehension of causes and results than an equally extended experience in mining or mechanical engineering would give, is utterly denied. The process of reasoning which some seem to emply is this: "Civil engineering is 'the art of directing the great sources of power in nature for the use and convenience of man.' *We* are civil engineers; therefore *we* are capable of directing the great sources of power in nature," etc. This is like the celebrated resolutions that, first, the earth is the possession of the saints; second, that we are the saints.

It certainly would be a great act of folly to underestimate the value of knowledge possessed and required by civil engineers in the construction of fixed works, which is usually of a very varied character, and in the correctness of which and the conclusions deduced therefrom, the gain or loss of large amounts of money often depend. Our protest is against the assumption of knowledge of subjects of which they are ignorant, and the inference that because they know about one class of things therefore they are acquainted with all others.

Probably the world would be benefited if the words engineer and engineering were abolished. There are perhaps, few others so vague and inexact. They cover vast mountains of humbug and incompetency. As there are no other words, apparently, to to take their places, and no authority to enforce their use if there were, there is no alternative except to continue their use. The only way to give them greater precision is by the addition of some limiting words. The present method of doing this seems to be incorrect; for example, if we paraphrase the term dynamic engineer, we have an engineer relating to dynamics, and a sanitary engineer, an engineer pertaining to health. It would be much clearer and more accurate to say an engineer of sanitary works. This would be capable of very extended application. Thus we would have engineers of docks, engineers of water works, of railroad equipments, of machinist's tools, of coal mines, of iron metallurgy, of pumping machinery, of masonry, and many other specialties whose number is increasing and will continue to increase very rapidly. This would avoid the liability to which the public is now prone, of going for advice about one thing to a person whose knowledge refers entirely to another, or of falling into such errors as asking for designs and placing the construction of an iron bridge in charge of a pe son whose whole experience and knowledge were derived from constructing bridges of stone, or *vice versa*, or of advising with another engaged exclusively in constructing hydraulic works about the manufacture of rails. By calling one an engineer of iron bridges, the other engineer of masonry bridges, we would state clearly the special knowledge which they possessed. At any rate the sooner some more exact designation of the different classes of engineers comes into use the better it will be for the members of that profession and the public at large.—*Railroad Gazette*.

NOTES.

The International Congress of Geography will be held at Brussels on Sep. 11, 1876.

Mr. James G. Hill has been appointed Supervising Architect in place of Mr. Potter, resigned.

In the first ten days of July 40 ships passed through the Suez Canal yielding a transit revenue of £33,160.

Over two hundred stone cutters were engaged at New York last week to go to Scotland on a two years contract.

The receipts of grain at New York have increased very much since the New York Central withdrew from the pool. For the week ending April 8, New York received only 13 per cent. of the grain going to the seaboard, while for the week ending July 15. it was 60 per cent. This high percentage is being kept up and is likely to be maintained for considerable time.

At present there is much complaint in New York City in regard to the quality of Croton water. The flavor of the water varies from day to day and is often quite unpleasant to the taste. The New York *Post* says:—The water of the city ought to be purified before the taste of our citizens becomes so vitiated as to render them unable to appreciate properly pure drinking water when they get it.

The Taunton, Mass., water works are rapidly approaching completion. They are on what is known as the direct-pressure system, hydrant pressure being maintained by the pumps for either domestic or fire purposes. The supply is taken from the river through filter beds, or in cases of emergency directly from the river itself. Mr. Holley is contractor for the pumps and Mr. O. A. Chapell, of Chicago, has the contract for the pipes. The capacity of the works is 2,000,000 gallons per day.

The first annual meeting of the Janesville Waterworks company of Janesville, Wis., was held on Aug. 18, and Dr Henry Palmer elected President. The report of the committee appointed to solicit subscribers was made and found to be very satisfactory, nearly every person solicited having subscribed. As soon as a sufficient number of consumers are obtained to make the enterprise a success, the requisite capital will be subscribed to complete the works at the earliest possible day.

Complaint is made of the water furnished the people of East Boston, which has been very offensive both in smell and taste, and is now so bad that it is considered unsafe for domestic purposes. A greenish substance, like that seen on the surface of a stagnant pool, is mingled with it, and rises to the top when left in any vessel, undisturbed, for a few minutes. Careful housewives boil and filter the water before they use it, and even then it leaves its odor on any article that may be cooked in it.

Contractors' Intelligence.

Port Royal, S. C., is soon to have an artificial water-supply.

Operations have been commenced for the enlargement of the Lachine Canal.

It is said that Senator Jones is to furnish the money for the Hudson River Tunnel.

The new life-saving station erected on Presque Isle has not been accepted by the government, as it was not put up in a proper manner.

The contract for building the addition to the State Normal School at Oshkosh, Wis., was let August 22 to Belle & Rogers, of that city, at $30,801.

The contract for furnishing the gas fixtures etc., for the group of buildings composing the County Hospital, was let on Tuesday to J. Hogan, for $1,875.

Work has been suspended on the new bridge at Harrison street, Chicago. The approaches and piers have been completed, and the city will build the superstructure when it is on its financial feet again.

The lowest tender for the Cornwall Canal improvements is that of Gordon & Co., of Sherbrooke, in which Mr. Brooks, of Brockville, is interested. If satisfactory securities are furnished the contract will be awarded to that firm. Their figures are said to slightly exceed $400,000.

The Louisville Bridge and Iron Company has the contract for two wrought iron draw-spans on the New Orleans, St. Louis & Chicago Railway, one being over the new canal at Magnolia street, New Orleans, and the other at Pass Manchac, forty miles north of that city, and the Louisville Car Wheel and Railway Company are filling orders for 600 car wheels for the same road.

The Pennsylvania Transportation Company consummated contracts on August 11 with the Pipe Manufacturers' Association for three hundred miles of pipe. Operations will commence immediately, and the line to the seaboard completed before the first of December. The engineers of the line are now receiving bids for pumps and boilers. The route is definitely located, and bonds are being taken rapidly at par.

The Mohawk & Hudson Manufacturing Company of Waterford, N. Y., have recently furnished a number of their "Eddy Valves" for the extension to the Water Works at Minneapolis, and also for the Winona, Minn. Water Works. They are now filling a contract for the West Troy, N. Y., water works for a number of the same kind of valves and "Bailey Hydrants."

Reform in Engineering Practice.

BY J. FRANCIS LE BARON, C. E., BOSTON.

[Written for Engineering News.]

I have read, with pleasure, the remarks in the NEWS of July 29th, relating to technical education of engineers in which is advocated an examining board for all intending to practice the profession.

This subject is of great importance and one that has occupied my attention for some time, and I am glad to find that others are beginning to seriously consider the matter. We of the east, are suffering from the curse of incompetency and unfaithfulness in the ranks of the noblest of professions, perhaps not as seriously as you of the west where the political office of county surveyor classes so many uneducated and irresponsible men as experts, but still we have here great room for improvement, which would be alike beneficial to the profession and the public.

As the case now stands, there is no legal or other bar to any one in the practice of civil engineeering. Any man who *says* he is an engineer and who has the requisite amount of *cheek*, *gift of gab*, and *influence*, is eligible to the best positions on Public Works, and to the lasting disgrace of the profession, he too often attains them. Of course, one, or all of these three factors will enter more or less, into every contest between experts, but when they prove of such importance as to foist an utterly incompetent and reckless man upon the community, in a place of public trust and importance, against the claims of old and tried fathers of the profession, it is surely time that some action was taken, not only by the outraged members of that profession, but by the abused and defrauded public. Yet these things are occuring every day, and with the exception of an indignant protest or two, no action is taken. I am myself knowing to the case of a man blessed (?) with an extraordinary large share of the three attributes mentioned who succeeded in obtaining in succession, three very important and high positions in private and public corporations, in the face too, of a spirited rivalry by men of established eminence in their profession, some of them members of the American Society of Civil Engineers, and yet he was as ignorant of the first principles of dynamics, statics, geometry, and trigonometry as a Sioux Indian. A man who could not run a railroad curve or calculate a bridge strain or even survey a three sided lot correctly, to save his life!

Now this may appear incredible and sensational but it is nothing more nor less than the strict truth, and that man is well known in this locality, but I am not afraid of his taking offence at this for his conceit is such that should he see it he never would once imagine *he* was meant, and what is worse, he has never been known to read or take a professional paper—with him "rule of thumb" is authority.

This man, too, held these positions for a long time and when he resigned them secured the most flattering recommendations. Such, Mr. Editor, is the gullibility of the American people. Such is the blindness of some of those old fossils who constitute the boards of public works, committeees, commissioners and directors. Such is the forbearance of a long suffering profession. You may ask how a man so utterly incompetent, such as I have described could possibly hold such positions, outside of the U. S. government. By hiring competent and able assistants, and "sitting on the fence" to get posted so as to be able to make a plausible report; this arrangement of "you tickle me if I'll tickle you," can be readily carried out. I have no doubt, Mr. Editor, but that you can call to mind many instances like this. I am sure that every engineer in this section can.

It is needless to dwell on the corruption of this kind that finds such food in the Public Land Surveys. It is notorious. Again, in the matter of prices. Here there is no restraint. The conscientious and painstaking engineer must stand by and see his pupil of yesterday awarded a case because he will agree to do it at a price which if *properly performed* will fall short of a dollar a day. But there is no critical examination and the matter passes, while the client congratulates himself on the saving of a fifty dollar bill. Ten years afterward he or his heirs lament his shortsightedness when settling a claim for damages of $5,000 or more. But he does the same thing the next time and trusts to luck.

In such a condition of things, it is truly refreshing to compare the action of the City of Boston in appointing a committee of experts, not members in the city government, to elect a City Engineer at the last election.

The many failures of reservoir dams, and the consequent fearful loss of life and property in this state alone, in the last few years, is too well known to need comment. The costly experiments, made at the expense of the public purse, on bridges and sewerage in this vicinity in the last few years, will not be soon forgotten. Does any one pretend to say that the majority of these accidents (?) might not have been prevented had competent engineers been charged with their construction? Instead, they have too often been subject to the approval or rejection of county commissioners with no technical knowledge at all.

In the matter of surveying, simple as it is in comparison, the same evil prevails but in a more exaggerated form. There is no uniformity in the practice of surveyors hereabouts. Some pains-taking men when called to decide upon a division line will make a careful study of the case, while others will quickly measure the deed distances and take it for granted that the point from which they start is right. Some will assume the street fence to be right, others will take the trouble to look it up and determine it from the city records. It often happens that the street line has been changed several times since the deed of the land you are surveying was written, and the determination of the line as it existed at the date of the deed is necessary.

Thus we see all kinds of plans on record. Some, (and they are very few) with the fences and walls as they exist and the true lines, also showing the discrepancies if any: others, by far the majority, show only the fences and walls, or else they show an imaginary line, and it is often almost impossible to determine which is which. The plan is nothing but a skeleton; the inside is a desert which is left to the imagination to cover with land marks. Now this is all wrong.

No plan is perfect that does not show every thing as if photographed from above, and besides, all theoretical lines, if they vary from the landmark, should also be shown and clearly indicated. *It is the duty that the engineer owes to his client to give him on his plan all the information bearing on the case, of which he is possessed.* But how often is this done? In scarcely a single instance. On the contrary very many engineers make a practice of impressing everything possible and yet have the plan pass muster, hoping that in the future their services may again be required and they receive a fee for what in honor and justice to their patrons should have been rendered at first. In this way the unsuspecting public are defrauded.

Of course no honorable or conscientious engineer will practice such treason to his clients, but still there exist (and I blush for the profession when I say it) too many cases and plans of this kind on record.

I know I am doing a rash thing to thus publicly expose the "tricks of trade." I do it to suggest a remedy. In the first place engineers must take the remedy into their own hands, for the public are ignorant that they are defrauded, and will even go to the cheapest or most popular man. It is to the *Societies* that we must look to rid us of the element of quackery, which I am sure all engineers deplore equally with myself in the profession.

Engineers must encourage the proper growth of their societies, and must *set the standard of admission high.* As a class, engineers have too much neglected the society and interchange of opinion that societies afford for their own good. The *press* is the next great power, the most important in this country for reform. The value to engineers of a home journal like ENGINEERING NEWS can hardly be overestimated. It is with the profession of engineering as it is with law and medicine. Left to struggle alone it is without strength or prestige; combine, and it is a power that will make itself felt throughout the universe. Societies must hold the same relations to engineers that the "bar" does to lawyers and the "faculty" to physicians, and all who have not a certificate of membership should be looked upon as quacks and shysters.

No enlightened board of public works or directors would engage them and we should have fewer startling accidents (!) the work of school boys, saddled on the profession. Your suggestion, Mr. Editor, of a law limiting the practice is an excellent one and could be best adjusted by the societies. A law prohibiting practice could not be enacted, probably, but it would seem as if it would be perfectly constitutional to require directors of works to be personally responsible, under bonds, for the work of their department, unless they employed an engineer recommended by the society, who would thus constitute, in reality, an examining board.

In the matter of surveying alone, the case is simple. No plans should be received for record at the registry of deeds, or by the clerk of court, or other party, except such as are made by engineers holding certificates from the society. Further, no conveyance of land should be legal unless accompanied by a plan of the same or a certificate from an engineer stating that a plan of the same had been recorded previously, according to law, and the lines were unchanged at this date. Not only should this be obligatory at every sale, as much as the record of the deed now is, but the law should require every division line and corner to be permanently marked by a stone monument set at least four feet deep in the earth with a drill hole to mark the point on the top. In this way thousands of dollars would annually be saved in every city in this commonwealth, which now principally goes into lawyers pockets, for as a general thing the parties who disagree about lines spend ten dollars on the lawyer to one on the engineer. Indirectly also it would act as a blessing to the whole country by starving out some of the swarming schools of pettifogging lawyers, and oblige these lazy vultures preying on the vitals of the community to work for a living at some respectable calling, where they would, possibly, be of some use, instead of disgracing the names of Choate and Webster.

Few engineers care to take up with such a business, because it is so unsatisfactory. If they make the requisite study of the matter, to definitely settle the case it takes so much time that they are sure to lose their bill, or at least a large proportion of it, and to cause hard feelings with their clients. If they do not take this course they must "fudge" it, which no engineer who values his reputation will do. Thus it will be seen at once that the profession is placed between two fires, and although the reform proposed might act to reduce a class of unsatisfactory work, still the satisfaction that comes from a feeling of work well performed would more than compensate, to say nothing of the additional safety of professional reputation.

At present to properly survey and make a plan of a lot the engineer has first to consult the registry of deeds, for the deed of this lot and all lots both ways to the first street corner. He must then look up what plans the registry affords. From the registry he must visit the office of the county commissioners or the city engineer to obtain the location of the street lines, provided the street is an accepted city, town, or county way. Otherwise, if it be a private way, he must search for the location of the street from the owner or his engineer. If a railway happens to bound a portion of the lot he must visit the office of the clerk of court for the location of the railway. If we happen to have a navigable water front we must visit the harbor commissioners to ascertain the location of of the harbor lines. By the time we have looked over all these musty old documents, examined and reconciled plans with deeds and plans with each other; got the locations of our underground bounds &c., from the note books, we, if not fit subjects for a lunatic asylum, have at least spent all our money in travelling, and several days time, which our client will think extortion to charge to him, and about which he will refuse to be comforted. Under these circumstances it is not much to be wondered at that men can be found, pendulums between Surveyors and dry goods clerks, hoping soon to get back into the store and having no reputation to establish, that will certify or swear to the correctness of lines of which they have made but a superficial examination. It is but justice to the defrauded public and the long suffering engineers that these matters be made the subject of legislative regulation, that will correct the abuses. I have confined myself to the State of Massachusetts in these matters. I should now like to hear from some other States.

Engineering Field Work.

[Written for Engineering News.]

V.

Location surveys differ from preliminary surveys in being more carefully carried out, as to the exact position of the line, and in the curve running which is usually omitted on the preliminary work. The exact position

of the line is a matter of great importance, for many dollars are thrown away by careless locations, and in many cases the theory of wilful ignorance is the only excuse that can be made for them. There are needed careful judgment, long experience, and a great deal of real hard work on the part of the engineer in charge of the locating party, to make successful locations.

The party is usually organized with the same force as in the preliminary survey, viz.: An engineer-in-charge, transitman, leveller, level rodman, two chainmen and from one to five axemen. To these are often added a topographer, and sometimes a cross-section leveller and helper, or rodman. The topographer takes sketch notes of the contours and surrounding country, roads, buildings etc., which have to be shown in the plans, and if he carries a pocket "azimuth compass" or a pocket sextant he will find it a great help to him, but for his work we especially recommend a small plane table 18" square with the paper on it in "block" fashion, the board fitted with a shoulder strap, and jacob staff mountings, and a folding "alidade" or ruler with sights. With this outfit a topographer can produce a line map which will make his chief engineer's heart glad, and which will go a long way towards convincing the directors that the party have done a lot of work. The use of the plane table for this purpose is not common, bnt such an arrangement costs very little, and nothing else will show as much of the country in a very short time. The field use of the instrument is very simple, the line already run being platted before taking the field, the "orientation" can be performed from stakes and it can be used anywhere.

The cross section levelling is only performed in very rough country; a ten-foot pole with a short spirit level placed on it, and then held with one end on the ground and the other against a graduated rod on which the rise or fall in ten feet is noted, is used; the information obtained in this way is very considerable; there is a good deal of work to get it but the men are not required to have a very high grade of mental organization and do not draw a very high pay.

All of the increased care and skill required and already mentioned has to come from two men—the engineer-in-charge and the transitman—the former has all the responsibility of the added importance of the survey, and the constant study of the ever changing ground, and the greater or less difficulty of the work itself; and the latter has all the curve work, with increased watchfulness and greater accuracy, to attend to; these two men have their work nearly doubled while the work of the rest of the party is only increased by the additional care and attention which has to be enforced on all the party.

To the engineer-in-charge we shall say very little, and to a man in that position little can be said—if he does not know his business he certainly ought not to be in the place, and if he does know it our advice is unnecessary, yet if he does not think it beneath him to read what we have to say to transitmen he may here and there find a hint to help him in watching the work of that indispensable assistant. And here let us say that no money is ever saved by making the engineer in charge of the location run either transit or level, as he needs all of his faculties to be at all times sharpened to their utmost degree to attend to his own duties, and if the tedious instrumental work is put upon him he cannot keep everything going at once properly. And here let us say that if the engineer-in-charge wishes to make every man do his very utmost, that he had better take the head of the chain himself when he can spare the time, especially on long tangents, which he has already determined. By so doing he will be near all the men of the transit party, and they will work when they are right under the eye of the "boss," and he will be sure that no time will be lost in picking out the transit stations and that the stakes are kept well up; the transitman will always hurry up to him, and if he cannot keep them all "on the jump" he is not fit for his place. Of course he has frequently to go ahead and pick out the ground, and go back to see how the profile will plat, and tell the transitman what must be done in his absence, and in this he must be his own judge of his time and of its disposition, but still, when he wishes to drive matters he can do so best from the head of the chain, in the mean time letting the head chainman take the transit rod and keep up the centers; the mental work which he has to perform all the time will not suffer from the mere manual labor of being head chainman.

The transitman has after all a hard place to fill, for there is no variety in his mental work; he has to keep a sharp watch on the men when his superior is absent, and has the constant computation of deflection angles to attend to on curves, at the same time using all possible diligence as to figures. And here a hint as to the easiest way of keeping the curve notes and doing the transit work. The method originated we know not how, and may have been used by large numbers of transitmen, although we have never happened to meet them; all that we can say is, that we found ourselves using it one day at the transit, while the engineer-in-charge was at the head of the chain, and we were very nearly driven out of our wits, for it was only our second day in the field with him, and we thought he was going to be "a tartar" although he proved really to be a very capital fellow.

The basis of all circular curve work with the transit is the well-known theorem: The angle between a tangent and chord, or between any two chords which meet at a point on the curve, is measured by half the intercepted arc." And as the point where the chords meet on the curve may be anywhere on that curve, it follows that the sum of any consecutive angles or series of angles is the same no matter where the instrument be placed on the curve for given arcs, and that if the deflection angles be all computed from the B. C. as far as may be desired, that at any station on the curve the numbers can be used, as the differences will be the same for the same stations. To illustrate this we must assume an example.

Let it be required to run a 5° curve from sta. 131 + 40 and let us first look at a page in a field book.

Sta.	Defl'cn	Curve	True course	Needle course
129			N 16¼° W	N 16° W
130				
1				
B.C.+40	0° 0′	5° R.	N 16° 15′ W	
2	1° 30′			
3	4° 0′			
4	6° 30′			
5	9° 0′			
+50	10° 15′			
6	11° 30′			
7	14° 0′			
8	16° 30′			
E. C.+25	17° 7½′	34° 15′	N 18° 0′ E	N 17¾° E

We see the book is ruled with five columns and usually on the left hand page, the right hand page being reserved for "remarks." The column for stations explains itself, the sign "plus" being used for a decimal point for a hundred foot unit, and the ordinary "decimal" being reserved for feet and fractions of feet. The letters B. C. and E. C. are used for beginning and end of the curve, instead of the P. C. and P. T. used often for "point of curve" and "point of tangent" as being more in accordand with the usage of ordinary geometry and has been our custom for several years.

The column of deflections contains the deflection angles computed from B. C. as far as convenient, say to station 135, and the stakes set and centered, for some reason 135 + 50 becomes necessary and has to be put in; then the transit is turned back to 0° and turned over on the back sight to be sure that nothing has slipped and carried up to 135 + 50 and set up. The instrument is then set at 0° and sighted at B. C., and then if turned to 10° 15′ it would be on the tangent at 135 + 50 and if turned to 11° 30′ it will be on the chord from 135 + 50 to 136, and by adding the 2° 30′ for each hundred feet the curve is run to 138, and the transit is moved to that place after taking a back sight as before, with the plates at 0°. After setting up at 138 if we could see B.C. we should set at 0° again, and turning to 16° 30′ we should be on the tangent; but B. C. is supposed invisible, and we shall therefore set the instrument at 10° 15′ and sight it back at 135 + 50 and the result is that the lower plate is in the same position as if B. C. had been visible, and we had as above suggested set at 0° and sighted thereat; by turning to 16° 30′ we shall be on the tangent at 138 and if we find that 1° 20′ more will be needed to strike the desired direction from there, we will put 1° 15′ more in the curve or 37½′ deflection which corresponds to 25 feet; we run out the 25 feet and turn to 10½′ and sight the stake in and then turning to 10° 15′ we turn over to the back-sight and, after satisfying ourselves that it is all right, we go to 138 + 25 and being sure the instrument reads 10° 15 we sight again at 135 + 50 and turn to 17° 7½′ and are at the tangent. By taking the differences and comparing distances it will easily be seen that the angles are all right.

Now in what does this method consist that is better than the practice of counting stations and multiplying by the deflection angle? Only this, that the counting and multiplication are both performed already. Each station is attached to the angle opposite to it in the note book, and once there it is good for all the work that you can do with it. The mental labor thus saved is a great help. It was once our fortune to have to "break in" two "green" transitmen in five weeks, and in all that time we computed every angle that was used at the instrument, mentally, and kept at the head of the chain most of the time; by asking the man at the instrument what reading he had and what station he was at and what his back rodman was at, we never let a mistake pass our notice. (Note, We are not anxious to repeat this experience of our transit running from the head of the chain.)

For the transitman himself this system of notes is a great relief as he is free from the constantly recurring question "what is your next deflection?" with its importunate worrying when he has just set up on an odd "plus" and knows that his back rodman is also on an odd "plus"; he simply asks himself, what are the readings for these two stations? knowing that the difference between them has been computed carefully once as they came along, and it will be all right now.

On compound curves the same method can be followed all round, but the back rodman and the instrument must be on the same branch, (the P. C. C. point of compounding of curve is of course on both branches).

The next column of the note book is headed "curves" and in it are recorded the degree and direction of the curves and the central angle, or angle of intersection, it is twice the last deflection angle always. In the next column is put the computed curves from the first one, and the next one contains the needle readings; the use of these is a check to the transitman's work, and sudden variations are not common. If "local attraction" exists it can be found by reading the compass at each end of the tangents. We remember a local attraction which bothered us immensely all one morning and which never seemed to be the same for two minutes running, and which quite frightened our "boss," but as we were within fifty feet of a north and south track we talked "earth currents" to him, (they were east and west) and as we were sure of our work we let it go unexplained; in the afternoon we discovered the innocent cause to be a small "Smith & Wesson" in our overcoat breast pocket, and we have never seen any such local attraction since.

Long straight lines require a good deal of care, and the instrument should be reversed "both ways" on them, and if a long sight can be obtained backwards so as to overlook two or three transit points they should be tested by the direct instrument. If great care is needed the instrument should be used "both ways" without reversing, and the slack of the clamp screws watched. Tangent screws are now so generally made double that the play of the motion screws can be prevented from interfering with the accuracy of the work, but the clamps will wear loose a little and must be watched. S.

What is a Civil Engineer.

To the Editor of the Railroad Gazette:

There seems to be doubt as to the meaning of the words engineer and civil engineer, which on your part is summed up in your answer to "Archimedes S. Watt," in the following:

"Our correspondent's remark about master mechanics coming forward and putting their shoulders to the wheels, or in other words of becoming members of the Society of Civil Engineers, suggests the idea that if it is considered desirable to have those who *are not* civil engineers members of that society, it would be well to drop the distinctive word "civil" from the title which *we know* now excludes some of the most able mechanical engineers in the country from allowing their names to be submitted for election to membership in that society. No change in the constitution is needed, as that instrument now permits the admission of engineers of all classes."

On this account I have investigated the subject, and submit the following definitions of the two words. The first is from the "Encyclopædia Britannica," third

edition, 1798, which is the oldest definition I find.

"*Engineer*—in the military art an able, expert man, who, by a perfect knowledge in mathematics, delineates upon paper, or marks upon the ground, all sorts of forts and other works proper for offence and defence. He should understand the art of fortification, so as to be able, not only to discover the defects of a place, but to find a remedy proper for them; as also how to make an attack upon as well as to defend the place."

From Brande's Dictionary of Science, Literature and Art we have:

"*Engineering*.—Strictly the art of managing engines; but latterly applied in a more extended sense, not only to that art, but to all manufacturing and building operations in which engines are used. It is divided into *two branches, military* and *civil*."

The definition of military engineering differs but little from the preceding:

"*Civil engineering*, as its name imports, does not include those branches above named which specially belong to the art of war; but relates to the forming of roads and bridges, railroads, the construction of machinery for all purposes, the formation of canals, aqueducts, harbors, drainage of a country, etc."

The rest of the definition is a condensation of Tredgold's descripfion of a civil engineer, which was given under the following circumstances:

"On December 29, 1828, the council of the Institution of Civil Engineers (London) desiring an act of incorporation—

"*Resolved*, That Mr. Tredgold be written to, requesting him to define the objects of the Institution of Civil Engineers, and to give a description of what a civil engineer is, in order that this description and these objects may be embodied in a petition to the Attorney-General in application for a charter.

"At the following meeting of the council on Jan. 4, 1828, the Secretary read the communication from Mr. Tredgold, which is thus entered in the minutes:

"DESCRIPTION OF A CIVIL ENGINEER, BY THOMAS TREDGOLD, HON. M. INST. C. E.

"'Civil Engineering is the art of directing the great sources of power in nature for the use and convenience of man; being that practical application of the most important principles of natural philsosophy which has, in a considerable degree, realized the anticipations of Bacon, and changed the aspect and state of affairs in the whole world. The most important object of civil engineering is to improve the means of production and traffic in States, both for external and internal trade. It is applied in the construction and management of roads, bridges railroads, aqueducts, canals, river intercourse, docks and storehouses for the convenience of internal intercourse and exchange; and in the construction of ports, harbors, moles, breakwaters and lighthouses; and in the navigation by artificial power for purposes of commerce.

"'Besides these great objects of individual and national interest, it is applied to the protection of property where natural power as the sources of injury, as by embankments for a defense of tracts of country from the encroachments of the sea or the overflowing of rivers; it also directs the means of applying streams and rivers to use, either as powers to work machines, or as supplies for the use of cities and towns, or for irrigation, as well as the means of removing noxious accumulations, as by the drainage of towns and districts to prevent the formation of malaria and secure the public health.

"'This is, however, only a brief sketch of the objects of civil engineering, the real extent to which it may be applied is only limited by the progress of science; its scope and utility will be increased with every discovery in philosophy, and its resources with every invention in mechanical or chemical art, since its bounds are unlimited and equally so must be the researches of its professors.

"'The enterprising Hollanders toward the close of the sixteenth century first separated civil engineering from architecture, under the title of hydraulic arhitecture; their example was followed in France toward the end of the seventeenth century, and soon afterward was systematized in the great work of Belidor on Hydraulic Architecture.

"'One of the great bases on which the practice of civil engineering is founded is the science of hydraulics; every kingdom, every province, every town has its wants, which call for more or less acquaintance with this science. Water, which is one of the most useful of the necessaries of life and the most dangerous element in excess, when limited by the laws of this science is rendered the best of servants; the rolling cataract which spends its powers in idleness may be directed to drain the mine, to break the ore, or be employed in other works of labor for the use of man; the streams are collected and confined in canals for inland traffic, harbors are formed to still the raging of the waves of the ocean and offer a safe retreat to the storm-driven mariner; and ports are provided with docks to receive the riches of the world in security; hence arose the term 'hydraulic architecture.' But it was too limited; the various applications of water had rendered the natural supplies inadequate to the wants of man, till he discovered that, combined with heat, it formed a gaseous element endued with energies not less powerful than the falling cataract; its steam confined and directed by science became a new source of power, which in a few years altered and improved the condition of Britain, and we are every day witnessing new applications, as well as the extension of the older ones to every part of the globe.'

"From which is derived the defintion of the Institution of Civil Engineers, viz.:

"'The art of directing the great sources of power in nature for the use and convenience of man; as the means of production and traffic in states, both for external and internal trade; as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks, for internal intercourse and exchange; and in the construction of ports, harbors, moles, breakwaters and lighthouses; and in the art of navigation by artificial power, for the purposes of commerce; and in the construction and adaptation of machinery; and in the drainage of cities and towns.'"

In the Society of Civil Engineers (English), sometimes called the Smeatonian Society (which was I believe the progenitor of the present Institution of Civil Engineers), whose first meeting was held in London, April 15, 1773, 24 per cent. of its members, including Boulton and Watt, were in no sense of the word constructors of "*fixed* public works."

Cresy, in the preface to his Dictionary of Civil Engineering, puts it much stronger, saying:

"In England the profession of the civil engineer was scarcely known until the middle of the last century, when the important discovery of the application of steam by James Watt and its rapid development called into existence a new class of *mechanics* who gave fresh impulses to manufactures by the improvement of all kinds of machinery."

Worcester's Dictionary says under the heading "Engineering:"

"Civil engineering—the art of forming, or the construction of roads, bridges, railroads; the construction of machinery for all purposes; the formation of canals, aqueducts, harbors, docks, drainage of lands, etc."

Webster gives:

"*Engineer*—A person skilled in the principles and practice of engineering, either civil or military.

"*Civil Engineer*—A person skilled in the science of, who designs or superintends the construction of public works or machinery. (See engineering.)

"*Engineering*—The science and art of utilizing the forces and materials of nature.

"In a comprehensive sense, engineering includes *architecture* as a mechanical art, in distinction from architecture as a fine art; *chemistry* as applied in connection with applied mechanics; *transportation*, including the building and propulsion of ships and other vehicles, docks, roads, bridges, canals and public works generally; *defense* and *offense* in the military and naval sense; *water-works, gas-lighting;* the *preparation of materials; machinery; manufacturing*, etc.

"It is divided into *military* and *civil engineering*, the former being, strictly, the science and art of designing and constructing defensive and offensive works, while *civil engineering* is the science and art of designing and constructing machinery and public works, such as roads and canals. Civil engineering refers, according to modern usage, strictly to the construction of *fixed* public works, such as railways, canals, aqueducts, bridges, lighthouses, docks, embankments, breakwaters, dams, sewers, tunnels, etc. *Mechanical engineering* refers strictly to machinery, such as steam engines, machine tools, mill work, etc. *Engineering* is further divided into steam engineering, hydraulic engineering, gas engineering, agricultural engineering, topographical engineering, etc."

From the Cyclopædia of Useful Arts, edited by Chas. Tomlinson, we have:

"Engineer and Engineering—Engineer is a term applied to those who are employed in devising or forming engines or machines, and in directing their applications. The duties of the engineer are divided into *military* and *civil*." [Here follows a definition of military engineering]. "Military engineering will not occupy our attention in this work; but the various important branches and ramifications of civil engineering will be considered under their respective heads. The profession of civil engineer, as defined in the charter of incorporation of the Institution of Civil Engineers, London, is" [Here follows the definition given above].

"Civil engineering is both a science and an art. As a science it includes the general principles of mechanics and construction; shows how we may ascertain the strains to which a structure is exposed; the dimensions and proportions which should be given to its several parts, so as to be able to resist such strains without injury. As an *art* civil engineering shows how scientific principles may be applied to the construction of works and how used and modified so as to meet the difficulties which constantly arise in practice."

This is followed by a "Synopsis of the Science of Civil Engineering," viz:

"I. Mensuration. II. General Construction. III. Mechanics, or Construction of Machinery. IV. Special Construction. V. Hydraulic Engineering."

I think that the above extracts show that Webster's Dictionary has small warrant for asserting that civil engineering refers strictly to the construction of fixed public works, and that while the greater includes the less, the word civil should not be dropped from the title of the American Society of Civil Engineers; or if it is dropped, it should be at the suggestion of the military engineers of the country, who so far do not seem to object to it.

N.

Railway News.

A road connecting Buenos Ayres with Azul (S. A.) was completed July 1st.

The railroad from Athens to Atlanta, Ga., will be completed this week.

There were opened in France during the year ending March 1876, 421⅞ miles of railway. France now has 12,436⅞ miles of railway.

A proposal is made for constructing a subterranean railway, nearly 14½ miles long, under the streets of Paris, the outlay being estimated at £5,480,000.

The Michigan Central Company are making their locomotives on passenger trains do double the duty by running double the distance. Each locomotive has two sets of men.

Track is now laid on the third section of five miles of the Gulf, Colorado & Santa Fe Railroad, westward from Galveston, Texas. Iron for ten miles more has been purchased in New York.

A road from Boston, Mass., through Everett and Melrose to Stoneham has been surveyed and a large portion of the right-of-way secured. A narrow gauge road between Boston and Woburn is talked of.

Long engine runs have been adopted on the New York Central & Hudson River Railway and have resulted in much increased economy both in locomotives and fuel. Engines now go through from Buffalo to Albany, 300 miles.

The grade of the extension of the Sioux City and Pembina railroad from Portlandville north is finished to Calliope. Track-laying will be commenced immediately and trains running to the latter point by the middle of September.

Track-laying is under full way at "the gap" of the Wisconsin Central Railroad. It is thought that the southern division will be finished to Portage by the 1st of September, and through trains to Ashland will commence before winter.

It is understood that the third rail of the Cincinnati, Hamilton & Dayton road which was laid to accommodate the trains of the Atlantic & Great Western road, will be taken up, now that the contract with that road is at an end. Such of the iron as is in good condition will be used in extending the second track to Hamilton.

Two new railroads have been incorporated in Iowa the Maple River R. R., which is to run from some point in Carroll or Green county, to Onawa, in Monona county, with a branch from there to Correctionville, Woodbury county. The capital stock is $1,000,000. The other is the Creston & Sioux City R. R., to run between those places.

The Burlington, Cedar Rapids & Northern Railroad Company propose to extend their road to Grundy next season, via Colfax, Lincoln, Black Hawk and Palermo, provided these townships will vote a tax of $43,000 to aid in the construction of the road. Under the present law no money voted by tax can be paid until the road is completed and cars running thereon.

The Baltimore & Ohio Railway has recently been making overtures for part of the overland traffic from China, Japan, etc. This move is quite favorably regarded on the Pacific Slope and we understand that arrangements very favorable to the interests of Baltimore have been made. This will give Baltimore increased importance as a shipping port for transcontinental freight.

A narrow gauge road is projected from Houston, Texas, to the Rio Grande at Presidio del Norte thence through the Mexican states of Chihuahua and Sonora to Guaymas on the Gulf of California. A branch will run northward from Presidio del Norte to connect with the Denver & Rio Grande. This route to the Pacific

will be only eleven hundred miles in length, about half of that of the Southern Pacific. Fifty miles westward from Houston will be completed by Sept. 1.

The San Francisco *Bulletin* says that without much noise, yet none the less effective, there is going on in California this centennial year more construction of railroads than in any previous period in the State's history. Nor is this construction of railroads confined to one section. In Northern and Southern and Middle California railroads are in progress which will tend in a short period to the further development of the State's resources. There is more raiload work going on in California at this time than in any other State in the Union.

We learn from the *Railway Age* that the three feet narrow gauge road from Des Moines, northeasterly, thirty-seven miles, to Ames, Iowa, completed in 1874, cost for grading, ties and iron $6,500 per mile. The four engines cost $27,000, four passenger coaches $10,500 and three baggage cars $4,500. The receipts from Jan. 1 to to July 1, 1876 were $20,047.71, and the operating expenses $15,000. During the month of July expenses were $1,971.93. The superintendent asserts that with a twenty ton locomotive he can haul as much paying freight as with a thirty ton locomotive on a standard gauge road.

Receiver Jewett's mission to England to perfect his scheme for the reorganizing of the Erie Railway has been successful. The plan he proposed was this: All of the mortgage bondholders down to the first consolidated are to receive their interest regularly. The first consolidated mortgage bondholders are to fund alternate coupons for six years. The second consolidated to fund all of their coupons for that period. The holders of common stock are to pay $6 per share into the treasury of the road, and the preferred stockholders $3 per share. The Board of Directors have ratified the agreement, the law passed by the legislature last winter making the scheme operative.

The Boston *Advertiser* says:—The latest railroad project thought of in connection with the new park at Grove Hall is an elevated railroad, starting at the junction of Kingston and Bedford streets, running down the former and out over Albany and Hampden streets and Grove Hall avenue to a point near Warren street. Here it becomes a ground line, turns to the right or left, and continues by a tunnel or cutting, parallel with Grove Hall avenue, until just beyond Wales street, where it emerges and follows Back street on the easterly side, crosses it beyond Oakland street, and ends in Hyde Park, near the junction of Huntington avenue and Westminster street. The proposed line is about seven miles long and this side of Grove Hall has no grade of any account, with the exception of the rises where the Boston and Albany Railroad passes under Albany street and where Hampden street unites with Dudley street The tunnel or cutting at Grove Hall would be nearly a mile in length. People from the city could be landed at the park gates in twenty minutes, and from the vicinity of Worcester square in fifteen minutes, and the line would run close to Mount Hope and Mount Calvary cemeteries and open up a new and large portion of the city.

The Dimensions of Narrow Gauge Railroads.

BY GEORGE PAUL, C. E.

INTRODUCTION.

In the following pages there is no claim made of presenting new rules or data to engineers who have made a study of the construction of railroads, nor that the conclusions arrived at are only applicable to the system of narrow gauge railroads, inasmuch as they are just as useful in the construction of any road designed for light traffic, in almost every instance, whatever the gauge may be.

It is the desire to present a train of reasoning by which any engineer, or even a person who has not made a study of engineering, can readily determine why it is advisable to give certain dimensions to the different parts of a railroad, such as width of cuts, dimensions of locomotives, weight of rails, dimensions of ties, etc.

In the construction of "narrow gauge" roads, builders have sought a new field to lessen the cost of constructing railroads; and in many instances they have thought that anything that was a "narrow gauge" would answer their purpose, and have only found out their mistake by sad experience; the general cause of failure being in not considering that they were using the same material to build their road that is used in constructing the roads of the common gauge, and that practice has demonstrated its value for that purpose; and they have permitted a disproportion, or lack of symmetry, between the parts—this mistake often occurring from not understanding the power of the locomotives employed to operate upon the grades they had established. There are now instances in which they are using locomotives of double the weight of driver of that first used, and the result is that they are overstraining their rails, wearing out their ties by an undue weight of rail base, and often have too little surface of tie upon the ballast, causing premature deterioration in the value of the material used.

In writing this work, the standard works on engineering have been consulted; also the discussions between the advocates of both broad and narrow gauge systems, in the current periodicals and in the publications in book and pamphlet form. Prominent among the former class are D. K. Clark's works, Vose's Engineering, Trautwine's Engineering, A. L. Holley's European and American Railway Practice, Rankine's Civil Engineering. Of the periodicals, the *Chicago Railway Review*, *Railroad Gazette*, *London Engineer*, *Engineering*, *Van Nostrand's Eclectic Engineering Magazine*. Of the latter class, Howard Fleming's "Narrow Gauge Railways in America," and the works of Robert Fairlie, prominent among which are "Gauges of the Future," and "Battle of the Gauges Renewed."

CHAPTER I.

Important among the leading questions which arise in the construction of a railroad are the following: What will be the nature and amount of traffic when completed? What shall be the least radius of curvature and the greatest rise per station for gradient it will be advisable to introduce? What shall the dimensions of the locomotive be? What shall be the weight of rail used? What shall be the dimensions of the fish-plates and spikes? What shall be the dimensions of ties? What shall be the depth of ballast, width of cuts and embankments? What shall be the dimensions of bridges to carry the traffic safely over streams and rivers?

In determining the answers to the above questions, it must be understood that a road to be operated successfully should have every part of such dimensions as will correspond in strength and utility with each other part, and each be capable of performing the duties required of it, without an undue strain being brought upon it. And upon further investigation it will seem that the different materials employed in the construction of a railroad act very differently under the strains to which they are likely to be subjected. It may seem that the total weight upon the driver is transmitted to but a very small space upon the head of the rail, and that when this force is transmitted to the wooden tie underneath, this area of contact must be increased many times in order that it may not destroy the cohesive properties of the particles upon which the base of the rail rests, by an undue pressure. And, again, this area must be increased in order to transmit the weight to a material having still less cohesive powers. Hence it will be seen that there are many different substances to enter into the construction of a railroad, and that the value of each should be distinctly understood for the purpose for which they may be designed to be used.

A locomotive must have certain dimensions to draw a train of sufficient tonnage to make the traffic of the road profitable, and these dimensions must be governed by the grades of the road. The weight of the engine, or its weight upon each driver, governs the weight of the rail to be used; and from this the dimensions of fish-plates, spikes and bolts must be determined; also the breadth of base of rail, to give sufficient bearing surface upon the tie. The weight of driver per tie also governs the area it should have to distribute the weight resting upon it, over space enough to prevent it from sinking into the ground, upon which it rests.

To decide the proportions and sizes most suitable for a road, the proper plan is to be governed by precedent whenever and wherever practicable; not by such precedent as may be found in many of the "narrow gauge" railroads now in operation in this country, nor by the dimensions of many of the parts of some of the roads of the ordinary gauge, but by the dimensions of the different parts of those roads which have best withstood the traffic for which they were designed. Such dimensions are arrived at by long practical experience and careful study, and may be found upon many of our principal roads. Once fixing these sizes, and knowing the duties they have to perform, we have a basis upon which we may determine what the required sizes should be for a road of lighter or heavier traffic. And in the following pages we have sought to show how the most suitable dimensions of the different parts of a road with a light traffic and using light rolling stock, may be obtained; the manner we have adopted being first to determine what may be considered standard dimensions for roads where the weight and dimensions of the rolling stock are also known; then to determine as nearly as practicable the amount of traffic the projected road is likely to have, and the weight upon each driver that it will be advisable to establish. These questions once established, a clear field for comparison with the dimensions upon the common gauge is open.

CHAPTER II.

Curves of a road are amongst the first questions to decide upon after a decision has been made to locate; and at times it is a difficult question to decide just what degree of curvature it will be most advisable to introduce. Many authorities upon this subject do not seem to take into account anything but the deflection of the curve from one tangent point to another, disregarding the number of degrees per station, basing the number of degrees total deflection as their standard for determining their objections to curvature; their data for such conclusions being obtained from experiments made to show the resistance due to certain degrees of curvature per 100 feet. From some of these we find the resistance to be 0.54 lbs. per ton for curve of one degree, and 3.24 lbs. (just six times the former amount) for a six degree curve. In equating curves and grades, the Pennsylvania Railroad Company considered the resistance due to one degree of curvature equal to 0.424 lbs. per ton, 2.544 lbs. per ton for a curve of six degrees, and would make a corresponding reduction in feet per mile from their maximum grade when upon a curve. This might have been correct so far as resistance to overcome was concerned, but not so far as the result of wear upon the rails and rolling stock or the danger from breakage or cars leaving the track. The principal objection to curvatures, which do not have to be contended with upon a grade, are that the resistance shown is made up by the abrasion of one material against another, while the other resistance is due to gravity. On curvature they are of such a nature as to increase the danger and expense of operating, with every increased degree of curvature per station. The resistance met with in the sliding of the wheels endwise is one which tends directly to throw the locomotive from the track; while the resistance due to the slip of the wheel, caused by the difference in the length of the rails, is one which tends to destroy the axle; and in strains from this cause the germ of many an accident has found foothold.

To show the relative objections to curvature upon different gauges, the following rules and data are introduced:

Latrobe and Knight's rule to determine the resistance from curvature in pounds, is

RULE 1.—Divide 0.578 by radius of the curve in miles.

Example: For one degree curve with radius of 1.069 miles, 0.578÷1.069=0.54 lbs. per ton.

During the location of the Pennsylvania Central Railroad, the following rule was used to determine the amount to reduce gradient for each degree of curvature:

RULE 2.—Reduce gradient 0.025 feet per station for each degree of curvature.

From the above rules the following results are obtained, showing the resistance in pounds per ton due to the different degrees of curvature. Columns 3 and 4 show resistance upon the ordinary gauge. Having once obtained these quantities and knowing the difference in length between the inner and outer rails of each system, we readily obtain the contents of columns 5 and 6, which show the resistances upon a 3 ft. gauge due to corresponding degrees of curvature:

Degree of curve.	Length of radius in miles.	4 Ft. 8½ In.		3 Feet.	
		Resistance in pounds per ton. 1st Rule.	Resistance in pounds per ton. 2d Rule.	Resistance in pounds per ton. 1st Rule.	Resistance in pounds per ton. 2d Rule.
1	1. 069	0.54	0.424	0.344	0.27
2	0.5407	1.08	0.848	0.688	0.54
3	0.3609	1.57	1.227	1.032	0.81
4	0.2522	2.29	1.696	1.376	1.08
5	0.2189	2.64	2.120	1.720	1.35
6	0.1808	3.20	2.544	2.064	1.62

To find difference in length in inches between the inner and outer rail upon any gauge:

RULE 3.—Multiply gauge of rails by 75.398.

Example: Gauge 3 ft. 3×75.398=226.2 inches.

Example: Gauge 4 ft. 8½ in. 4 ft. 8½ in.×75.398=-355 inches.

To find radius of "narrow gauge" having same resistance from slips on rail as that upon the common gauge, of known radius:

RULE 4.—Multiply difference in length of rail in inches of narrow gauge by radius of ordinary gauge and divide by difference in length of rails upon common gauge.

Example: Difference in length of rail 3 ft. gauge, 226 inches; difference in length of rail 4 ft. 8½ in. gauge, 355 inches, and radius of 4 ft. 8½ in. gauge, 573 feet, or 10 degrees curve. 226×573÷355=363 feet.

In order to find the coefficient for narrow gauge, of friction in pounds per ton due to each degree of curvature, to correspond with that given in Rule 1, for coefficient of resistance upon the common gauge, the following rule is applicable:

RULE 5.—Multiply difference in length of rails upon narow gauge by 0.578; divide by difference in length of rails on common gauge

Example: Difference in length of rail 3 ft. gauge, 226 inches; difference in length of rail 4 ft. 8½ in. gauge, 355 inches. 226×0.587÷355=0. 3679.

RULE 6.—To find coefficient given by Pennsylvania Central, substitute 0.424 in place of 0.578 and proceed same as above.

Example: 226×0.424÷355=0.27.

A careful observation of the above rules show the advantage of the narrow gauge system, whenever it becomes necessary to introduce curvature. It may be seen that the degree of curvature per station may be about 50 per cent. greater upon the 3 ft. gauge than upon the 4 ft. 8½ in. gauge, with no greater disadvantage from slip of wheel.—*Railway Review.*

Machine Tools at the Philadelphia Exhibition.

ENGINE LATHES.

In respect to engine lathes we will begin by saying that among the various exhibits here will be seen a diversity of arrangement and proportions which will be a matter of astonishment to foreign visitors. No other machine tool has reached such uniformity of design and arrangement in Europe as the standard engine lathe, while of the exhibits here the opposite may be said.

Nearly every lathe conveys an impression of special adaptation, which is in some measure true and explainable by the fact that tool-makers understand the wants of the country, and adapt their machines to these wants, while in England lathes are more an article of merchandise, and are sent out to all countries and for all kinds of uses of which it is impossible the makers should have previous knowledge.

It is a matter of surprise that among the numerous firms making engine lathes in the Eastern states, but two or three are represented here. Perhaps three-fourths of the lathes produced in America are made in New England, and when this is considered, it accounts in a measure for the lack of uniformity before mentioned. Worcester, in the State of Massachusets is the great lathe-making centre; but there, as in England, lathes are quite a stereotyped production. They are made nearly all on one model, of almost uniform weight, and with a very constant arrangement of feeding other gearing. The price is also uniform, or nearly so; the business is learned, and we may say conducted, as a manufacturing rather than as an engineering one; the result being, as is generally the case under such circumstances, that the cost of producing is often considered before quality and adaptation.

Before noticing what is peculiar in American lathes, it will be proper to make some remarks upon turning and the use of lathes compared with the practice in Europe, for without some knowledge of this no one is prepared to judge of the merits and adaptation of many of the tools shown here.

The process of turning is different in England and America. In some kinds of work it would be the same, but generally the cut taken here is much less. A light cut and high speed seems to be the plan followed, and the result, all things considered, seems to justify the method when applied to practice here. Round iron or steel to 2½ in. diameter is "turned on one-sixteenth of an inch," as it is called; that is, the finishing and rolling diameters have only this differance. Standard dimensions for shafts, and we may add for all turned work in most engineering shops, is by odd sixteenths, instead of by eighths as with us, and there is no doubt much gained, besides a saving of material, by working on such close dimensions. The loss occurs from extra care required in strengthening and centering work; but even this is, in most cases, compensated by having the best of the material on the surface.

Turning tools employed here are generally more pointed, especially for work which has to be true; and when we consider that, in most cases the, truth of work does not depend so much on the stiffness and strength of a lathe as it does on the rigidity of the pieces turned and the strain of cutting, there seems to be a strong reason in favor of a fine feed and pointed tools.

To sum the matter up in an illustration, the American idea of metal cutting is "coaxing;" the English is "forcing." Such diversity of practice is not the result of accidental circumstances. By examining the general practice, reasons for it will be found, two of which we will name: proportions for machinery of all kinds, and especially during former years, were much lighter in America than in England. This feature not only extended to the designs for lathes, but also enabled them to be made lighter, because of their duty being less. A second reason is because it is customary, especially in the Eastern States, for one workman to operate several lathes, so that the time of turning a shaft was of less importance than having a lathe to operate without continual attention, and every one knows that to leave a lathe when cutting, a fine feed is preferable to a coarse one.

In turning the parts for reaping and mowing machines, for example, the shafts and spindles are usually prepared during the winter, so that the machines can be rapidly assembled and erected during the spring months, when they are shipped from the works. The lathe work is done by the piece, often by boys, who attend from two to four lathes. The mode of operating found most efficient is to feed at from 60 to 80 per inch, using tools which have an inclined edge, like a side tool, toward the cut, and a mere point of contact against the finished shaft. This, of course, relates to roughing out or reducing the transverse strain on the work, and all strains on the lathe are not one-half what they would be in turning on the plan practised in England where broad point tools and a coarse feed is the rule.

What has been remarked in the case of reaping-machine work applies to a large share of the turning done in America, and explains what otherwise seems strange, that their lathes are made so light and with so many details for adjustment. It is common also to have lathes of a capacity much greater than the diameter of pieces require. A 10-in. lathe is employed for work which in England would be done on a 6-in. or an 8-in. lathe, a rule which has some advantages, but leads as a natural result to lighter proportions. Another thing which does much to modify their construction, is the various kinds of work performed on them. Drilling, milling, boring, and even wheel cutting, are frequently performed on lathes, especially in the western country, where repairing and other irregular work makes up the greater part of what is done. In such cases they become a kind of combination machine, and many adjustments, such as a movable tail-stick for turning taper forms, are traceable to this varied use of lathes.

We now come to speak of the peculiarities of American lathes as contrasted with the general practice of European makers, and we scarcely need remind our readers how impossible it is to have knowledge of, or to even keep in view, all the various known facts in dealing with machine-tool construction. Changes follow so fast, and so many peculiarities in construction never reach public notice, that even in treating of the subject in a general way it is difficult to include all that is worthy of notice. This difficulty we will attempt to evade in some measure by not confining what is said to the exhibits here, but include so far as possible anything worthy of attention in the general practice of the country.

With very few exceptions American engine lathes have angular ways on which the carriages move. Flat top frames, such as are made in Europe, have never met with much favor here, a matter perhaps not to be wondered at so long as those having angular ways are sold at low prices, and no distinction made in this respect between the two plans. This preference for angular ways we may safely assume to be based upon something more reliable than theoretical premises, to which the Americans, as a rule, give very little attention, and the presumption is that a true and steady movement of the carriages has become a feature to which more attention is given than with us. As before explained, the method of turning requires accuracy of movement rather than a capacity of resisting severe strains; and that a carriage moves easier and with more steadiness on angular ways, no one accustomed to both plans will dispute. There is no intention of entering into a consideration of the subject here, further than to discover some of the more prominent reasons for American practice, but of one thing we may rest assured, that there is some substantial reason always to be found when one method more expensive than another is adopted, a rule which applies in this case.

In the construction of planing machines it is well known that the only means of securing a movement true enough to procure true surfaces of any length is to rely upon the gravity of a carriage instead of mechanical guidance, and so far as we can see the same principle applies to the carriages of lathes so long as they are not subjected to strains which from their direction or extent will lift a carriage from its bearings. When the strains upon a lathe carriage are considered, especially with the American method of turning, it is easy to see that for the smaller class of lathes it is very seldom that a carriage would be moved from its bearings upon angular ways. Many lathes made by some of the best firms, Messrs. Pratt and Whitney among the number, are at this time constructed with what is called weighted carriages, and it is a fact well known that for performing true work such lathes are the most reliable so long as the carriages are not lifted by undue strain, which seldom occurs except in boring. The theory on which these angular ways are constructed is that with proper proportions of the bearing surface on the top and sides of the ways, the wear is compensated each way, and a carriage never becomes loose. Any wear of the ways causes deviation of a carriage in a vertical plane only, which for turning is a small matter when compared with the effect produced by deviation in a horizontal plane.

To sum it up in a few words, the Americans think that the bearing surface secured by a flat top frame, does not avail anything in securing a carriage from deviating in a horizontal plane, and it is this deviation which should be guarded against; also that a carriage held down by angular gibs can never be kept tight enough to secure steady movement.

Large lathes are made, as in Europe, with gib carriages on flat frames, and we suspect that the true system lies somewhere between—that angular ways are best for small lathes, and flat frames for those subjected to severe strains or for boring. It is also customary in America to mount the fixed and sliding heads on angular ways, the same as the carriages. On this point we may safely assume that no other plan of securing and maintaining alignment is so simple and effective.

The alignment of a lathe, like the movement of its carriage, is especially important in horizantal plane, and certainly no mode of construction will secure this so well as V ways with an equal angle on each side, whether such ways be raised above or are sunk into a frame. We therefore conclude that this feature of American practice is good, although in the history of machine tool-making it may seem to belong to a period and practice now passed away. Another result of some importance gained by mounting the sliding heads of lathes on angular ways is that the main frame is clamped together when the head is fastened. With a very rigid frame having plenty of transversive stiffness this may not have much importance, but with frames such as are for the most part employed in America considerable rigidity is gained by thus clamping a sliding head at the point where the most severe strains fall.—*Engineering.*

THE DHU HEARTACH LIGHTHOUSE.

In the Proceedings of the Institutions of Civil Engineers for April 25, 1876, is a very interesting account of the Dhu Heartach Lighthouse recently completed under the direction of D. & T. Stevenson, M. M. Inst., C. E., after six years spent in its erection, and at a cost of £65,784.5. This light is situated on the Dhu Heartach rock at the entrance to the Irish Channel, 19½ nautical miles S. E. from Skerryvore, and 27 nautical miles N. from the Rhins of Islay, in the route of the Quebec and other steamer lines to Liverpool and the Clyde, the nearest land being 14 miles distant.

The difficulties encountered in its erection were on the whole quite similar to thsoe met by Smeation at the Edystone, by the Stevensons at the Bell Rock and the Skerryvore, and by Douglas & Walker at the Bishop and the Wolf, these difficulties being common to all the exposed lights on the Atlantic coast of the British Isles. The literature of these lights is well known and valuable to lighthouse engineers and all who have to do wirh harbor construction and similar works, and the account of the Dhu Heartach light is doubly interesting, in that the forces here met seemed abnormally developed.

The sketch of the Admiral by chart accompanying the report, shows that from the Atlantic, commencing at the 100 fathom curve, a submarine valley made directly in in to the Dhu Heartach rock, which concentrated and intensified the waves from the ocean to several times their normal dimensions and force, in a manner quite similar to the production of the high tides in the Bay of Fundy.

The rock itself is abomt 240×130 ft., rounded top, rising to a hight of 35 ft. above high water of ordinary spring tides. The tower consists of a parabolic frustrum with a maximum diameter of 36 ft. and a minimum of 16 ft., surmounted by a plain cavetto, abacus and parapet, the upper course of which is 107½ ft. above the foundations. It is of gray granite weighing 3,155 tons and built solid to a hight of 64 ft. 4 in. The focal plane is 145 ft. above sea, and the light is visible 18 nautical miles. The stones were all dressed and fitted on shore and laid in place on the rock when it was possible to effect a landing, that being but 244 days in the five years required to complete the masonry.

The first thing done was to build a barrack for the use of the workmen so that the work might progress when it might be impossible to effect a landing. This consisted of a malleable iron framing rising to the hight of 35 ft. above the rock, surmounted by the barrack proper, a drum of ¼ in. iron 16 ft. in diameter and 18¾ ft. high, divided into two stories. On the 20th of August, 1868, a week's storm set in, of such violence that heavy broken water fell on top of this drum, 77 ft. above high water level, excluding the light for several seconds, and the flooring, although 55 ft. above high water, was struck with such force as to burst open the hatch. On the 8th and 9th of July, 1869, when part of the third course had been laid in cement and joggled at a level of 35½ ft. above high water, a storm tore up 14 stones of 2 tons weight each, and 11 of them were swept off into deep water. The hight of the solid portion of the waves at this place is 64 ft. 4 in. above high water, while at Skerryvore it was but 30½ ft., at Bishop, 23 ft., at Chickens 21 ft., and at Wolf, Bell Rock, and Edystone, from 10 to 16 ft.

The hight of the solid wave here is in a measure due, no doubt, to the configuration of the rock as well as to the concentration in the submarine valley. Since the work was completed, the lightning-conductor of copper, 1½"×1" fastened by counter sunk screws every five feet, into a raglet 1¾ in. broad by 1 in. deep, has been torn from its position in four places, one at an elevation of 92 ft. above high water. Other instances of the force of the waves at great elevations are recorded. The old Bishop iron pile lighthouse was destroyed by the waves striking the floor of the lantern gallery at an elevation of 85 ft. above high water, and in the new Bishop lighthouse, the fog bell of 3 cwt. was torn from its bracket at an elevation of 100 ft. Heavy seas have struck the tower on the Fastnet rock, on the coast of Ireland, although the top of the rock is 70 ft. above high water; and at the North West lighthouse on a rock ¾ mile off the northernmost of the Shetland Islands, though the tower was situated at a level of 196 ft. above high water, northwest gales have produced seas sufficient to overthrow the boundary walls and burst open the doors of the house. At Skerryvore, contiguous to Dhu Heartach, but with less hight of solid wave, the dynamometer of Thomas Stevenson recorded the greatest pressure yet noted, viz., three tons per superficial foot. Other lights of remarkable engineering difficulty have been executed under English direction in the past few years, notably, the Great and Little Basses lighthouses off the coast of Ceylon. We have also many excellent examples of difficult lighthouse construction in this country as Minots Ledge lighthouse, and others along the New England coast, not to mention some fine examples of iron lighthouses on the Florida Keys and the Gulf coast.

WATER SUPPLY OF SAN FRANCISCO.

San Francisco is quite seriously considering the question of water supply. Owing to the distribution of rainfall on the Pacific slope and the topographical features of the country it is quite impracticable to obtain a pure water supply sufficient for the prospective needs of the city short of some of the rivers of the Sierra Nevada Range, or the numerous lakes of the range itself, about a hundred miles distant. This necessitates works of immense magnitude and cost.

On Aug 18, Mr. W. V. Clark made a proposition to the Water Commissioners of San Francisco, which, if carried out, will make one of the most extensive systems of water supply in this country, not excepting the Croton supply system of New York.

He proposes to take the water, from a group of lakes known as the Blue Lakes, in Alpine County, Cal., at an elevation of 10,000 ft. above the level of the sea, and 150 miles in a direct line from San Francisco. Here he proposes to provide storage for 10,000,000,000 gallons of water, with available capacity for 10,000,000,000 more when needed. From these lakes the water will flow down the granite canon of the N. Fork of the Mokelumne River thirty-nine miles, to a point 3,000 ft. above the sea, thence diverted into a canal fifty-one miles in length, which will bring the water to a point about thirty five miles easterly from Stockton at an elevation of 1,500 ft. above the sea. This canal is to be 5 ft. deep, 6 ft. wide on the bottom and 10 ft. wide on the top, lined with hard marble stone, a cross-section of 40 sq. ft., a fall of 6.4 ft. per mile and a capacity of 150,000,000 gallons daily. The proposed line crosses the Calaveras River midway between Belota and Jenny Lind. Ffteen miles from the Mokelumne is the first reservoir at an elevation of 2,500 ft. and eighteen miles further is a grand reservoir on the summit of Greasewood Hill, at an elevation of 2,500 ft.

From the end of the aqueduct or canal he proposes to lay a wrought iron pipe, with a capacity of 50 000,000 galls. daily. This pipe line will cross the San Joaquin about midway between the mouth of the Stranislaus and the city of Stockton, through Livermore Pass, skirting the hills of the Diablo Range, around the head of San Francisco Bay and following the San Mateo shore to a terminal reservoir 400 ft. above tide in the south part of the city. The pipe will be 44 in. in diameter to Livermore Pass and 40 in. thence to the city.

At the western outlet of Livermore Pass at an elevation of 500 ft. above tide a reservoir will be built with a capacity of 18,250,000,000 galls.

The length of this pipe line is not given in so many words but it is stated that the total length of pipe is 134 miles, and that the Livermore reservoir is to be within sixty miles of the city. From figures elsewhere given in the report in the San Francisco *Chronicle* from which these facts are taken, the length of pipe from the extremity of the canal to Livermore reservoir would be about 70 miles and the head 1,000 ft. From Livermore reservoir to the terminal reservoir there is but 100 ft. fall , 135 miles for the total length of the pipe line is probably correct. The total distance from the Blue Lakes to the terminal reservoir would be 224 miles.

Mr. Clark makes three distinct propositions in which he offers to sell his rights to the Blue Lakes and works already constructed for $500,000; in addition to build fifty-one miles of canal, the two reservoirs, and the Livermore Reservoir for $3,500,000, or to complete the entire line of work from the Blue Lakes to the terminal reservoir 400 ft. above tide, complete for use for $12,000,000, and to receive in payment 6 per cent. semi annual gold-bearing bonds of the city and county of San Francisco.

The proposition is regarded favorably and no doubt San Francisco will ultimately adopt it or some similar scheme. Some of the San Francisco papers, however, accuse Mr. Clark with a rabid desire to sell his water privilege.

Dr. Wm. Fields, of Wilmington, Del., has applied for a patent for steel belting. He claims that it is lighter, more durable, and less expensive than leather belting. It will not stretch or get out of shape and the lacing is more simple and expeditious. For ordinary belting it does not need to be over 1-16 inch in thickness. We shall expect much of this invention as something better than the ordinary leather, or the various canvass and rubber combinations, has long been a desideratum among manufacturers. If steel belts could be made to secure the same rigidity of movement without danger of slipping, as in cog gearing, it would be one of the most important inventions of the age. Gearing is but a clumsy device at most, and the amount of power lost by that method of transmission is in the aggregate, very large. In the single matter of pumps, it is well known that it is not expedient or economical to drive a pump piston at more than 50 to 100 ft. per minute while a much lower speed is more frequently chosen. No limit except one of mechanical construction has been found as yet for piston speed for steam engines, from 500 to 1000 ft. being not exceptional. With high piston speed goes economy for a given power both in the first cost of the engine and in the consumption of steam. The question then, is how in a pumping engine, to combine a high piston speed in the steam cylinder, with a low piston speed in the water cylinder, and thus combine the greatest economy in construction and maintenance with a high duty. This has been attemtped in a few cases, by means of clumsy cog gearing, which may, and probably does, negative to a great extent the economy to be expected. An instance of this kind is the Vergennes pump, but we have not the statistics at hand by which to judge of the economy of the combination. Should some form of the steel belt prove adapted to such cases by giving a movement of requisite positiveness, we hope inventors will take the hint which we throw out, and see what can be done toward realizing the economy to be expected from combining a high speed steam piston with low speed water piston.

A great many enquiries having been addressed to the Navy Department, at Washington, in regard to the contemplated inter-oceanic canal between the Atlantic and Pacific, a statement has been authorized to the effect that, in November last, the Canal Commission having examined the reports of surveys of the several routes, united in a report recommending the Nicaragua route. The Secretary of State communicated with all the Great Powers in reference to the project and received hearty promises of co-operation, and the draft of an agreement relative to the construction of the canal, embodying the spirit of the Clayton-Bulwer treaty, was drawn up and transmitted to the Nicaragua government for their concurrence and approval, and that they have, as yet, failed to respond. This failure on their part has prevented any active steps being taken. Costa Rica is alive to the prospective benefits to that country as a portion of the line will constitute a part of her boundary or be very close to it. Another statement in regard to the Colombian route, by Cacarica Pass and Tuyra river, is going the rounds, to the effect that on May 29th the Government of Colombia signed the contract and ceded to Gen. Farr, the territory required for a canal across the Isthmus of Darien. These statements are, however, to be taken with a good deal of condiment.

Peter Papin in the Port Royal (S. C.) *Commercial* of Aug. 12, claims for that port the only deep water harbor on the Atlantic coast south of Norfolk, and claims for it the proper terminus on the Sea Board of the Southern Pacific Railway, and for ocean lines of steamers to European and South American ports; due to its geographical position in reference to the prodncing country to the west and northwest, and to its deep water harbor. What he says in regard to the advantages of the harbor is no doubt true, for the port of Savannah is difficult of access for deep draught vessels, and Charleston has a shallow channel over the bar which has greatly changed and become much worse, owing to

the stone feet sunk off the entrance to the harbor during the civil war. Port Royal, or Hilton's Head was at that time the principal point of rendezvous for our coast squadron. All the arguments in regard to a seaboard outlet by Charleston which the Chicago Board of Trade adduced last winter and for which it has sent out two committees to excite interest in the project, will apply equally or with greater force to Port Royal. Of course it may be very difficult to change the course of trade from the old ports of Savannah and Charteston; and this is more particularly true at present, owing to the apathy in which the south is steeped. But this is not to continue always, and already Port Royal has two lines under way to connect with roads to all points in the west and northwest. We are hardly as sanguine as the writer, however, who ends his communication with the following peroration: "South, awake from your slumber; a better commercial future is reserved for you. South, Southwest, West, and Northwest, prepare yourselves to welcome the new and economical shipping outlet offered to you for your direct-trade intercourse with the world, via the superior and deep-water harbor of Port Royal, the future Liverpool of the United States."

JETTY PREJUDICES.

We present this week the paper read by E. L, Corthell, C. E., Engineer-in-charge of the South Pass Jetty Works, at the annual convention of the American Society of Engineers, June 15th. It is intended to be supplementary to a paper read one year previous by W. Milnor Roberts, in which the theories in regard to the proposed jetty improvement were presented. Mr. Corthell has corrected the tables and brought them down to the 1st of August, and he promises to keep the readers of ENGINEERING NEWS informed, from time to time, in regard to the results obtained. A careful study of the tables brings out many interesting facts which, however, are discussed in the paper. It is due the profession that the fullest facts should be presented, in regard to all the changes that have taken place and are taking place, and no doubt it will be done in proper course of time. It is a great experiment and the paper argues its success, but whatever the ultimate result may be, even if it should prove an absolute failure, after some millions are paid, engineers will not feel that the money is thrown away, provided that the facts are so presented that the forces and the results accomplished by their action can be studied and conclusions drawn that will be available in future works. The various newspaper statements that have been presented from time to time are quite unreliable and, in addition, the facts on which an engineer could base an opinion, have not hitherto, except in the government reports, been given. We do not attach any particular blame to anyone, but we think much unnecessary prejudice has been awakened against the enterprise for the simple reason that an engineer is necessarily somewhat skeptical in regard to conclusions when he is unable to examine the facts on which they are based, especially when these conclusions are put forth by interested parties. However frank they may be, with engineers, as to a greater extent with other people, "the wish is too often father to the thought."

Nothing certainly can be lost by giving the widest publicity to all the facts, and the reputation of Mr. Corthell will ensure their reliability. Engineers will draw their own conclusions and none but confirmed croakers will misinterpret them. In the mean time we wish the enterprise every success, provided none of the "laws" of the universe are reversed; and when we draw, what is to us, an honest and correct conclusion from the facts presented, we hope not to be accused of bias or favoritism. We believe there are subjects involving conflicting interests, even in these days, on which a judgment may be expressed without the judge being a partisan.

HIGH WATER IN LAKE MICHIGAN.

In our issue of July 29th, we gave tables showing the level of the lake for a series of years. Much enquiry having been elicited, we repeat the table then given, with additions up to date, and also add an additional table giving the weekly means for July and August. Those of our readers who may take a farther interest in the subject, we refer to the issue mentioned for a discussion of the results. The lake reached its highest level, thus far in the year, about the middle of July, and appears on the whole to be gradually subsiding. However, should the rainfall in the lake basin exceed the average during the coming month, we may expect higher water probably in November. High water is reported from various points on Lake Huron and also at Detroit and at Duluth on Lake Superior.

ELEVATION OF LAKE MICHIGAN FROM 1854 TO 1875, INCLUSIVE.

Year.	Max.	Min.	Mean	Greatest monthly mean.	Least monthly mean.
1854			1.83	May & June 2.58	Dec.	1.02
1855	3.45	0.15	1.56	September 2.07	Jan.	0.76
1856	3.05	0.42	1.60	May & July 1.90	Dec.	1.20
1857	4.35	0.60	2.42	August	3.14	Jan.	1.00
1858	4.69	1.33	2.90	Nov.	3.86	March	1.85
1859	4.45	1.31	2.98	July	3.90	Jan.	2.27
1860	3.53	1.30	2.54	July	2.93	Dec.	1.55
1861	4.40	0.90	2.56	August	3.86	Jan.	1.73
1862	3.30	1.20	2.59	June	2.90	Dec.	2.00
1863	3.30	0.70	2.10	June & July	2.40	Dec.	1.70
1864	2.80	-.80	1.57	May	2.05	Dec.	0.70
1865	3.66	-.40	1.30	August	2.02	Jan.	0.40
1866	2.50	-1.80	1.07	August	1.60	Feb.	0.37
1867	2.60	0.00	1.49	July	2.08	Jan & Nov.	1.08
1868	2.58	-.41	1.01	June & July	1.55	Dec.	0.41
1869	2.13	-1.00	1.13	August	1.83	Jan.	0.25
1870	3.25	0.41	2.09	June & July	2.58	Jan.	1.25
1871	2.80	-.30	1.77	July	2.50	Dec.	0.75
1872	1.80	-.40	0.81	August	1.28	Dec.	0.29
1873	2.70	-.76	1.40	August	2.07	Feb.	0.37
1874	2.80	-.20	1.67	August	2.21	Dec.	0.72
1875	2.90	-.90	1.41	August	2.04	Feb.	0.59
	4.69	-1.80	1.805		3.90		0.25

ELEVATION OF LAKE, 1876.

Month	Max.	Min.	Mean
January	1.80	0.60	1.26
February	2.50	0.40	1.55
March	2.83	1.30	1.87
April	2.90	1.37	1.92
May	3.50	1.90	2.68
June	3.50	2.60	3.05
July	4.20	2.80	3.43
August	3.70	3.00	3.38
Year (thus far)	4.20	0.40	2.39

WEEKLY MEANS, (July and August.)

Week ending July 8	3.29
" " " 15	3.59
" " " 22	3.44
" " " 29	3.34
" " Aug. 5	3.47
" " " 12	3.32
" " " 19	3.47
" " " 26	3.30
Aug 26-31	3.30

On Wednesday of this week, a bill was filed in the Circuit Court for an injunction against the County Commissioners and others, to restrain the execution of the stone contract on the new Court House, under the bid of McNeil & Son. It was agreed by council that in the meantime, no steps should be taken toward the execution of the contract, the application to be argued this (Saturday) morning before Judge Farwell. The bill sets forth in substance: that bids have been received from nineteen different parties; that the lowest was from Patrick Fanning at $535,000; that the contract was awarded to McNeil & Son at $540,000; and that although Fanning gave good securities and was competent to the work, it was let to McNeil & Son. Also that these bids, were virtually from one and the same firm, a contract having been made between Fanning, McNeil and Hennesy on May 23d, in which they agreed to share equally all the profits if the contract was awarded to any of them. McNeil & Son are said to be "incompetent, unskilled, and insolvent," the quarry of Edwin Walker, to be filled with chalk and other disintegrating matter, and otherwise unsuitable, etc. It is asked that the contract of McNeil & Son be declared fraudulent; that the Board be enjoined from executing the same. Preparations are making by the County Commissioners to lift the mortgage on Walker's quarry with the view of accepting the bonds of McNeil & Son on Monday. The disappointed stone contractors are quite jubilant and confidently expect a re-letting.

Pipe and Hydrant Bids at Lake View.

The Board of Trustees held a special meeting Wednesday night for the opening of bids for additional water-pipe, all the members being on hand. Preliminary to the business in order, a resolution was adopted authorizing A. J. Weckler, Assessor, to purchase all property in the town of Lake View offered for sale by the County Treasurer for special assessments of 1875-'6 not bid on by outside parties. The town having advertised for 12,200 feet of 6-inch and 8,125 feet of 4-inch pipe, with sixteen hydrants and twenty-two valves, the following bids were received: George C. Morgan & Co.—Pipe, $33.75 per ton; castings, $48 per ton; valves, $16 and $24; hydrants, $44; laying, $5,468.64, or $16,139.39 for the whole job. International Pipe Co.—Pipe, $34.38 per ton; castings, $48.78. Edward P. Allis & Co.—Pipe, $34.16; castings, $48.94. H. R. Smith & Co.—Pipe, $34.58; castings, $51.20. John and H. J. Duffy—6-inch ptpe, 77 cents per foot; 4-inch 63 cents. Clark & Raffen—For castings, $50. Bids for laying were: Hanslein & Lange, 30 cents per foot; Philbrin & Owen, 6-inch at 20 cents, 4-inch at 17 cents; sheet piling, 14 cents; Keating & Smith, 6-inch at 48 cents, 4-inch at 42 cents; John McHugh, 6-inch at 25 cents, 4-inch at 20 cents; B. Langen, 6-inch at 24 cents, 4-inch at 20 cents; John Duffy, 25 cents. Bids for valves and hydrants were put in by Samuel I. Pope & Co., James Flowers & Co., John McArthur, Ludlow Valve Company, Union Hydraulic Machine-Works, and Mohawk & Hudson Manufacturing Company. The Board then adjourned to Monday, Sept. 4, when the award will be made.

NOTES.

Steam street cars are a success in Philadelphia.

The iron rails on the Castle Shannon Railroad are being replaced by steel ones.

The Washington monument is to be 485 feet high, which is just five feet higher than the pyramid of Cheops of Egypt.

In a few days the Board of Public Works promises to authorize the building of the dam over the Ogden Ditch. This will head off one nuisance.

The receipts in totals on the Erie Canal up to July 31, amounted to $257,083; against $96,827 last year. The decrease in grain shipment is only 481,191 bushels.

Grand Rapids has over 25 miles of sewers and 131 miles of streets opened. The total expenditure for the city water works up to May 1, was $350,756.44.

The stockholders of the New York and Long Island Bridge, better known as the Blackwell's Island Bridge, offer three prizes for the first, second, and third best plans.

Mr. E. A. Garvey, formerly assistant engineer of East St. Louis, has been appointed engineer of the Canton Wrought Iron Bridge Co., with headquarters at Waterloo, Iowa.

The trouble from the Mystic water at Boston, is found in the growth of vegetable matter in Horn Pond. Measures will be taken immediately to remedy the nuisance.

Glen Falls, N. Y., although recently provided with water works at an expense of $60,000 to $80,000, is troubled by the failure of her water supply; cause, dry weather.

The government of Canada has decided not to exclude American boats from the use of Canadian canals for the present season. Some definite action will probably be taken next winter.

The prospects of the Chicago Exposition this fall are looking up, and it is probable that in spite of the big show at Philadelphia the display here this fall will surpass that of any other year.

An English company, with a capital of $10,000,000, has purchased the water power at the great falls of the Potomac, 14 miles above Washington. Caleb Cushing and other Massachusetts men were large owners.

As showing the extent of the canal interests in this country, in 1840 there were 8,500 miles of canal in operation. The Erie and Champlain canals, however, are the only ones that ever paid a dividend on the investment.

The N. Y. *Herald* says the Croton reservoirs are merely catch basins for the filth of the country, and that the surface water will have to be shut off or else the Croton basin depopulated in order to preserve the purity of the water supply.

A bar has formed in front of the lake connection of the Evanston, Ill., Waterworks, and it is impossible to obtain a water supply for more than an hour at a time. A pipe will probably be carried out to 1000 or more ft. in the lake to 10 feet of water.

The estimated cost of completing the Fullerton Ave. Conduit is $150,000. Arrangements have now been made by which the city will pay the contractors a portion af the amount due them, and they will carry the re-

mainder, two-thirds or more, until the city is able to pay. Thus the early completion of this important work is assured.

New Haven is much worked up about its sewers, garbage and bad tenement houses. A committee, consisting of two aldermen, three councilmen and the chairman of the road commissioners, has been appointed to consider the best and most practicable plan of ventilating the public sewers, and is warranted to investigate to the expense of $500.

An appropriation of $8.000 has been made by congress for dredging the harbor and improving the channel of the river at Menominee. This will in a very few year be one of the finest harbors in fresh water. The narrowest part of the river, as far as navigable, is not less than 300 feet wide from dock to dock, and vessels can now leave the harbor drawing 13 feet of water. The government pier on the south side is 1,800 feet long.

The South Boston flats are being rapidly reclaimed, and will probably be finished by Spring. The sea-wall is nearly finished, and the contractors are also building the walls for four docks. 800 and 600 feet in depth. The area to be enclosed by the State is about 12,000,000 feet, which will give a great extent of available wharf front, and a new avenue called Northern avenue, is to be built. The Boston Wharf Company is filling up the eastern portion of the flats, and in less than a year 100 acres of solid ground will be ready for occupancy.

The great purchaser of breadstuffs is England, who buys them wherever they can be got to advantage, though now she chiefly gets them from the United States. With an annual consumption of 180,000,000 to 200,000,000 bushels of wheat, England grows barely 80,000,000 or 90,000,000 bushels, so that she has to get more than half her supply abroad. Formerly the Black Sea country of Russia sent England about one-half her imports of wheat, but this is now reduced to one-fifth; and the United States sends to England one-half her imports, while the proportion is constantly increasing.

The matter of the levees is once more being agitated, and inquiry has been made as to when the usual surveys will be made. Gen. M. Jeff Thompson being quite ill in Missouri, will not make the sruvey this year, but W. C. Melvin, A. F. Wrotnoski and H. B. Thompson of the Board of State Engineers, will accompany the Commission of Engineers, in September, for the purpose of assisting them in locating, and to stake out the levees, to be built during the levee year—1876–77. It is supposed the commission will start between the 5th and 10th of September. They will also be accompanied by Mr. M. W. Danton, engineer for the Louisiana Levee Company.

At Kansas City, the Kansas River has rambled quite at will through an alluvial bed, frequently, in time of flood, changing several hundred acres from one side of the river to the other. The Kansas Stock Yards in order to protect their front, has thrown out wing dams, made of log cribs filled with stone, and in the course of a year a strip of land 100 ft. wide, and half a mile in length has been reclaimed, and the river channel deepened to double its ordinary depth. It is intended to throw out farther wing dams on the Kansas, and also the Missouri River, and when sufficient land is reclaimed to rip rap the river front, securing at the same time protection from farther changes and a channel depth available at all times for the largest Mississippi and Missouri craft.

Railway News.

Russia has 11,772 miles of railways.

The survey of the Herkimer and Newport, N. Y., railroad is completed.

Track is laid on the Cincinnati Southern Railway, 35 miles south from Cincinnati.

The Elmira and State Line, N. Y, Railway is finished as far as Millerstown, nine miles.

The Government has sued the Mo. Pacific Railway Co. for back taxes amounting to $200,000

Engineer's are busy surveying a railway line from Houston, Texas, to Shreveport, Louisiana.

We learn that work on the Miami Valley, Ohio, Narrow Gauge Railroad will commence immediately.

The western terminus of the International Railway is now at Round Rock, seventeen miles from the city of Austin, Tex.

A stock company has been formed for the purpose of building a narrow-gauge road from Oswego, Kan., to Trinidad, Col.

Work has been resumed on the New York elevated railway on Greenwich street between Eleventh street and Ninth avenue.

The survey of the Boston & Stoneham Railway (narrow gauge) is completed and the work of construction will commence soon.

The Canada Southern Railway is to build a grain elevator at Amherst Bay on the Detroit River and also to run a line of propellors from that point to Duluth.

Jacob Wirth, Esq., Superintending Engineer of the Elm-street Inclined Plane, Cincinnati, now announces that the road will be in running order on the 1st of September.

The Chicago, Milwaukee & St. Paul Railway Co. will proceed immediately to the construction of a new depot on Washington Avenue, St. Paul, to be completed in sixty days.

It is expected that the track now under construction by the Green Bay & Minnesota Railway from Winona Junction to La Crosse will be ready for operation by the first of October.

There are about 360 miles of railway in Mexico of which the line from Vera Cruz to the city of Mexico (263 miles) is probably the most difficult line on this continent. Its cost was $27,000,000.

The grading on the Rockville branch of the Connecticut Central railroad is completed, and the iron is being laid, and the managers hope to have it in readiness for business by Sept. 1st.

Dangerfield, Titus county, Texas, raised $13,000 to induce the East Line Railway to pass through that place. This road has now one locomotive running. The work is going on very rapidly.

A new passenger engine is being built for the New York Central & Hudson River Railway with drivers 6 feet 4 in. in diameter. Its performance is to be compared with the standard passenger engine with 5 ft. 8 in. drivers.

The Directors of the Lamoille Valley Railway have completed a contract with the Portland rolling mills for 3,500 tons of rails, sufficient to complete their road from Johnson to Swanton. It is expected now that the road will be open through to Lake Champlain this fall.

A party of engineers from the Boston, Barre and Gardner Railroad has commenced the survey of the proposed Peterborough and Hillsborough Railroad, beginning at the terminus of the Monadnock road, and will meet a party from the Northern road at Bennington, Vt.

Work on the Dayton & Southeastern Railway, Ohio, is progressing rapidly, and the track will probably be down to Jamestown by the 30th inst. The President desires to complete the road as soon as possible to the intersection of the Marietta & Cincinnati Railway at Chillicothe.

Work on the Omaha and Northwestern Railway, from Herman to Tekamah, is now under full headway, and track-laying is in progress at the rate of half a mile per day. Eighty cars of ties and sixty cars of rails have passed through Omaha for the road. About fifty men are employed at the present time.

Lord Dufferin, Governor General of the Dominion of Canada, etc. in his recent visit to British Columbia and Vancouvers Island discouraged the early construction of the Vancouvers Island Railway, at which the inhabitants of said island are quite irate, threatening to do all manner of things which they do not intend.

A preliminary survey of the new Schenectady & Utica Railway has been made. The new route includes among its possibilities a line from the Hoosac tunnel to Schenectady, Utica and Oneida, and from that point via the Midland to Oswego and the Shore Line to Buffalo. Among the subscribers upon the books now open are Justice Ward Hunt, Isaac Maynard, Philo Remington, William Clark, S. M. Richmond, William D. Walcott, Daniel Crouse and others in this vicinity.

The Galveston *News* reports the rails laid two miles beyond Seguin, work progressing rapidly, 150 hands being employed. Passenger trains run to the Guadalupe river, Monday. Permanent bridges are in process of erection at the San Geronimo River and Mill Creek. The section of the senate bill prohibiting donations of land in counties where a railroad was already built, was stricken out in the House.

About eight hundred men are engaged in building on the Wisconsin Central Railroad between Worcester, 101 miles north of Stevens Point and Penoka, thirty miles from Ashland. The company expect to get through the forest to the lake by next Spring. Fifteen miles of ties have been laid this year so far, and by the end of the season twenty miles more will be down. The branch road from Stevens Point to Portage will be completed by the 1st of October. The Central is the only company at work constructing a road in this State this year.

The work of changing the track on the completed portion of the Harrisonburg and Fredericksburg Railroad to a 3-foot gauge commenced last week, and up to last accounts had progressed at the rate of half a mile a day. The engineers are approaching Harrisonburg, and are expected in that town in a few days. They report having found an easy grade over the Blue Ridge. It is the purpose of the Royal land company to put the road under contract from Orange Courthouse to Rawley Springs at once. The work is to be completed in twelve months.

The report of Gen. Newton and Col. Adams to the directors of the Brooklyn Elevated Railroad Company favors the single-rail plan of Roy Stone. The rail consists of a triangular trestle work, and the car is saddle-shaped. One of the advantages secured by this arrangement is the impossibility of a car or engine leaving the track, except by being lifted a considerable distance Placed on single posts on the side of the street, it is estimated that a road constructed on this plan would cost $100,000 a mile, while the cost would be $130,000 per mile if the road was to span the street.

In Chandler against De Graff and others, on appeal, the Minnesota Supreme Court holds as follows: A contract to furnish ties and other material, and to construct and complete a definite line of single-track railroad for a given compensation payable in installments as the work progresses, upon monthly estimates of the amount of work done and materials furnished, is a contract for work and material and not of sale; until placed in the track the property in ties furnished under such a contract remains in the contractor, even though prior thereto they may have been inspected by the railroad company and included in the monthly estimates.—*Railway Gazette.*

A trial was made on the narrow-gauge railroad between Des Moines and Ames, thirty-eight miles, as to the quantity of fuel consumed. The train consisted of the engine, weighing 14 tons; mail and express car, 7 tons; two coaches. 35 passengers each. 14 tons, making a total of 35 tons. The locomotive was built by the Grant Locomotive Works, has six 42-inch drivers; cylinders 10 inches in diameter, with 16-inch strokes. The trip to Ames and return was made with 1,000 pounds of bituminous coal, or 22½ pounds per mile. The rate of speed was twenty miles per hour. The trip was also made with one coach less, with 740 pounds of coal, or 9¾ pounds per mile. The grades are the average found on all roads in Iowa.

Winnipeg papers notice frequent arrivals of steel rails via Duluth, the Northern Pacific Railway, and the Red River, for that portion of the Canadian Pacific, 115 miles, between Winnepeg and Rat Portage, near Lake of the Woods. The Canadians have already graded the branch from Winnepeg to Pembina in expectation of the early construction of the St. Paul & Pacific to that point, but becoming tired of waiting, are pushing that part of the Canadian Pacific between Manitoba and Thunder Bay on Lake Superior, 406 miles, to an early completion, about 300 men being engaged on the Western Division. This road will be a serious detriment to the interests of St. Paul, who, with proper energy, might have held the traffic of this region for several years. On the Thunder Bay end locomotives are already running, some 25 miles of road having been completed, and probably the 60 miles between that point and Lac des Mille Lacs will be constructed before the end of the season.

Engineering Instruments at Philadelphia.

[Special Correspondence of Engineering News.]

III.

Wm. J. Young & Sons, of Philadelphia, make an extensive display of their excellent and well-known instruments. With the exception of a plane table the exhibit is very complete. Most of the instruments are open to free inspection, and the attention is called to several improvements and attachments, some of which are covered by patents owned by this firm. For example, the tangent screw, for moving the upper plate is covered throughout its length, the two sleeves having between them a concealed spiral spring, which is designed to prevent any lost motion; the eye-piece is focussed by a milled-edge nut which gives a very steady and gentle motion; the lower plate is moved after clamping, as is now commonly the case, by two opposing screws, but an interposed spring allows the cross-hair to be brought exactly on the object by the use of one screw alone, the spring holding the clamp-stud finely against the point of the screw; the object-glass has a sleeve over the outside of the telescope, so that no sliding surface is exposed, and a ring of felt or cloth prevents all entrance of dust; a ring attached to the upper plate and lapping well below the lower plate also protects the joint between the two plates from dust. The glass cover of the vernier is engraved with several lines corresponding with the principal ones on the vernier, and the observer when reading the angle, by holding his eye so that the lines will coincide, will avoid parallax. This very serviceable improvement is patented.

They exhibit a twenty-two inch level and an eighteen inch level to which they apply both a spring upon one wye to prevent rotation of the level, and also what they call a *web fastener*, a small projection attached to the clasp of the wye, and engaging in a notch on the ring on the telescope. They also show a seventeen inch level, in which the change of focus of the object-glass does not alter the length of the instrument.

Seibert's solar transit and mining instrumeut has the solar apparatus placed on the upper plate, somewhat towards one edge; the standards are inclined sufficiently to allow the telescope to be directed vertically, and a reflecting eye-piece, not shown on this instrument, but often added by them enables one to observe any vertical angle easily.

The Gradienter, used by this firm, is applied to several of the instruments on exhibition. It consists of an arm to be clamped at pleasure to the transit axis, carrying at its lower extremity a milled headed screw which works horizontally in nuts on the two legs of one standard. The number of divisions on the edge of this milled head which pass a scale also attached to the standard indicate the amount of vertical movement of the telescope. The number of complete revolutions of the milled head are shown by the divisions on the scale itself. The amount of rotation required to apparently displace the horizontal hair one foot on a staff at a given distance having been previously ascertained, distance can be readily measured by means of this attachment.

Burt's marine Goniometer, devised by the inventor of the solar compass, is composed of circular graduated arcs, so connected together as to show the relations of the parts of a spherical triangle. It will therefore mechanically reduce nautical observations. The instrument is probably too complicated and delicate for use by ordinary sea captains.

A neat and compact little transit for preliminary surveys or reconnisances is shown; also a very simple telescopic hand level for the same class of work, and for grades in which a totally reflecting prism brings the level bubble into the field of view. This instrument is claimed to work to within an inch in two hundred feet.

Messrs. Young & Sons also exhibit a forty inch Meridian Circle, graduated on silver by themselves, and destined for Yale College. The limb is divided to two minutes, and the reading microscopes, of which there are five at different points on the circle, will indicate seconds, and admit of an estimation of fractions of that minute space. The graduated arc as seen through the microscope is beautifully distinct and the marks are clearly cut. We inspected the dividing engine upon which this work was done at the work-rooms of the firm, No. 43 N. 7th St., and were much pleased with the care and good workmanship which had been applied to its construction. This firm have also two other dividing engines for smaller work.

A United States Coast Survey instrument, manufactured by Messrs. Young & Sons. which has been in use some time, was kindly loaned by the Department for this exhibition. The "First Transit," about which some very interesting articles have appeared in the NEWS, is placed here among its more showy brethren. Although it is very plain and simple, and has passed through great vicissitudes, it is still capable of doing good work.

Although the exhibitions made by the various makers heretofore named make, collectively, a large and important display of the articles described, still it is a matter of great regret that no Chicago or Boston makers are on the list. Perhaps these firms intend to send something yet. It is also noticeable that many New York makers are not represented. Buff & Berger of Boston are down in the official catalogue but seem to have no instruments here. They have put up quite a number of photographs about the west gallery of the main building, in the vicinity of the civil engineer's room. The pictures themselves are not all that can be desired but they help one to see that this firm make good instruments and quite a variety of them. Among those who have not sent anything are included some of our best makers. The exhibition is very far from being completed although comprising so much of worth and novelty. Perhaps it is as complete as could be expected; certainly the variety of instruments shown is great. There is a disposition manifested by the makers to produce whatever may be called for and to adapt their constructions to whatever variety of work they may be needed for. While it is cause for regret that more makers are not represented great satisfaction may be derived from the fact that the display is very creditable to the country at large. This satisfaction is likely to be much increased by a comparison of the U. S. display with that of other countries. England and Switzerland show instruments of as fine or even finer workmanship than those of American make generally, but those shown by other nations come very far from equalling those of our own country in suitability to the purposes for which they were designed. In the matter of *capacity* the American instruments lead all the others. In the case of suitability of design there may, of course, be quite a difference of opinion, but I think no American has cause to buy a foreign made instrument on this account.

The next exhibit examined was that of J. Kern of Aaran, Switzerland. It is unnecessary to refer here to this maker's reputation; the instruments shown will only add to it. He shows a collection of his celebrated drawing instruments, the finest made in the world. Besides these there are three transits, three levels, and what may be named a Universal Instrument, though I do not know the name the maker intended it to bear. The three levels are of the same general design as those usually made in Central Europe. One of these levels seems to have been made for very accurate work and some points of its construction will be given. It is a Y level. The bar is close under the telescope, the level being on top. The wyes pass below this bar. One is connected by a hinged joint to a second bar below the first. The other wye is connected to this second bar by a fine screw so arranged that by operating with it any inclination between the two bars may be established within small limits. This also answers the purpose of an ordinary adjustment of the wyes. There is a little set screw on the telescope abutting against a stop on one of the wyes. When the horizontal wire is once set this screw can be set so as to just touch the stop. Ever after, when the instrument is in use, it is only necessary to turn the telescope in the wyes till the screw touches the stop and the horizontal wire is in the correct position for an observation. This little device is very handy, and I have often felt the want of just such a contrivance. Still I have always gone on without really giving thought enough to it to design anything to accomplish this purpose. I hope the inventor will accept my thanks for relieving us all from one of those pestiverous little things that we have not ourselves been sufficiently aroused about to get rid of. I have no doubt but this little thing conduces very much to accuracy in work.

The level tube, which is on top of the telescope, as before noted, is a true striding level and its feet stand upon the telescope bearings. The tube is encased in wood to guard against changes in temperature and overheating. The feet of this striding level are held in place, so that it will not drop off when carrying the instrument along, by means of the clips to the wyes. Each of these has a slot in it that embraces a stout pin projecting from the foot of the striding level. This design is very efficient and neat. The level cannot turn or fall off while it may be easily and quickly removed, for reversion or any other purpose, by opening the clips to the wyes. Tnis level has three levelling screws. These have spherical knobs on their lower ends that set into cavities in the tripod cap. The instrument is held in place by turning straddle clips over each one of these knobs and securing them by screws, as the wye clips are commonly secured on a Wurdeman transit. This arrangement seems to me to be unnecessarily cumbersome and tedious in operation. I think there are many better ways of securing a three screwed instrument to the tripod than this. Still I have found, too frequently, that a maker has some good reason for adopting a construction that seemed to me bad, to condemn the one alluded to wholly without knowing the maker's mind upon the subject. The eyepiece and the crosswires are together moved by a milled headed screw in order to bring the crosswires into the focus of the object-glass for an observation. This arrangement is the one frequently criticised adversely in the Wurdeman instruments. It should be avoided in small instruments like engineering instruments. There is not accuracy of fit and length of bearing surfaces enough in small slides to warrant its use. The lost motion at the rack and pinion operates to throw the wires out of position in all the cases where I have seen it used.

The instrument that I have called a universal instrument is very peculiar in construction and if exhibited to excite our curiosity certainly ought to be a great success. The workmanship is quite above all but favorable criticism. The telescope and attachments are similar to those of the level above described but the wyes are carried on the concave side and at the ends of a segment of a brass tube. The construction wherein this brass tube is used is well known to be common in European work of this kind. This tube has, at its middle and on its under side, two lugs projecting downwards. They are a little distance apart being on opposite sides of the center line of the tube but at the same distance from its ends. Through the lower ends of these lugs pass hard steel scews. These screws are brought to a point at their inner ends, that is, their ends that point towards the center of the instrument. These hard steel points embrace the top of a column so as to take the place of the transit axis in a transit, or more like the horizontal axis of a theodolite. On one hand, one of these screws projects beyond its lug so as to be fitted with a clamp and slow-motion screw for controlling the motion of the telescope about its peculiar axis. The other screw is provided at its outer end with a segmental vertical circle. The vernier to this is fixed to the plate of the instrument below. This circle answers the very same purpose that the vertical limb of a theodolite does. The little column upon wnich the telescope is perched is fixed at the center of the plate. The lower plate is on top of a second column from which project four arms in which work four levelling screws. These screws pass upwards against the under side of the lower plate to level it. This lower column upon which the whole thing is set is cast in one piece with the tripod cap. By this time it may rightly be inferred that this instrument is exceedingly high and apparently unstable. What it was designed for it would be hard to guess. Perhaps it will appear in the judges' reports.

The transits shown have three levelling screws and open spoke-wheel plates. Of course they are very light. Wyes start out from center of upper plate; there are levels on top of the telescopes; the telescopes are not mounted near their center of gravity and are therefore balanced by great pieces of brass, of irregular shape, fastened to their lighter ends, giving this part of the work a decidedly clumsy appearance. This is especially true after one has recently seen and tried the movement of the five Heller and Brightly telescopes. One is surprised at every point in examining the work of this Philadelphia firm, to see the extreme care and judgment with which every detail is worked out. One cannot well help referring the work of other makers to theirs as a kind of standard with which to compare it.

The focussing of the object-glass for an observation is accomplished in these transits as in the level first mentioned. The vertical circle is balanced by a weight, and there is evidence that care has been taken to make these constructions balanced machines, There are reading glasses to the various verniers. One cannot avoid the impression that these instruments are somewhat clumsy though the elegance of the workmanship and evident effort to realize theoretical principles in their construction may command admiration. The general error in the design of all the instruments here shown is that they are all too high, without exception, and much higher than the demands of the designs require.

It is a matter of great regret that the French have not, for some reason, shown more than they have. There are, of this class of instruments, but two rude and clumsy little architects instruments. They are very rough in their construction. Besides these there is a little plane table quite as rude as the rest. This show is not made for want of French skill in workmanship or design. It does not at once appear why it is made.

In the English section there is shown by Negretti and Zambra, of London, makers to the Queen and Royal Observatory at Greenwhich, the following list of instruments: A very fine English Theodolite, one of those rare pieces of workmanship which the London makers produce; a Dumpy Level, two Sextants, a fine Protractor, Compass with folding sights, and a Prismatic Compass. They are all of good standard English patterns. There is but one peculiar feature about these instruments to be mentioned: that is the exceptionally good quality of the work. I think this collection cannot be surpassed in this respect by anything of the kind which I have seen. It seems too bad that they should be tucked away in the bottom of a case, a kind of lower part beneath the apparent bottom, where they cannot be found without searching.

The firm of Heam and Harrison, of Montreal, Canada, have on exhibition a plain Engineer's Transit, American pattern, Dumpy Level, an English Theodolite, and a very large Y Level, likely for canal work. This firm can learn something in the way of workmanship from the home nation, and much in the way of design. The great Y level stands on such a small pair of levelling screws that it looks insecure, to say nothing of untrustworthiness.

Austria shows one instrument for the purpose of exhibiting Kreuter's Tacheometer. This tacheometer is not likely to find favor with Americans, I should say, from what I have seen of it, because it will seem quite clumsy to them and adds too many attachments to an instrument.

Sweden has contributions from two firms, J. P. Ljungstrom, Stockholm, and J. L. Rose, Upsala. The first shows a very rough plane table, and the second a needle compass which must remain an object of curiosity as it contains more strange features in its construction than can easily be found in one instrument. Neither instrument will be copied by our home makers.

The catalogue says Norway has an exhibit of this kind but I cannot find it.

Portugal has, in the main building, quite a few instruments that possess considerable merit.

It should be said in closing that the French may intend to put their show of these articles in the building devoted to their Public Works.

Our own government has some of the coast survey instruments in the government building. Spain has some in the Spanish building. This gives a nearly complete list of what may be found here in this line. This exhibit, as a whole, must be regarded as quite defective, especially from foreign countries, so much so that in some instances there is no just grounds upon which to make a comparison with other nations. Perhaps this is but a truism applicable to many another line of manufactures in the Great Exposition. J. B. D.

Engineering Field Work.

[Written for Engineering News.]

VI.

In Railway Field Work, after the Location Survey, follows legitimately the land survey or "Land Lines" as they are called in the east, and although most of this work is included in common surveying, yet there are some points of difference which it will be well to touch upon. In cities and towns where land is valuable, it is of course quite important to have the work done accurately; and although in the western country where the land is very commonly given to the railroad company it is not so essential, still it is always desirable to know how to do good work, and a few words as to general surveying will scarcely be out of place.

In the first place be sure that your work is definitely connected with points which can be found again, and that the connection with the main line is right, and that it is simple; any complex measurement is to be avoided. In the next place measure every distance pertinent to the work which can be directly measured. Calculate as little as possible. If the land to be taken is very irregular in form, a "traverse" is the best method of attack if all the sides can be measured; don't have any "omissions" to supply if you can help it; be careful to take all offsets at right angles; take the angles with a transit if one can be had, and do not use the compass in any way but as a check on the transit; for sighting right angles quickly, some of the forms of the "optical square" may be found very convenient; for ordinary work in cities most of the measurements for land will be at right angles or nearly so, and the work can be laid out on four lines forming a trapezium; do not trust to any building for a right angle or to any two walls of the same building to have parallel faces; brick laying is not by any means the most exact of trades, and although for a map the errors will not show, yet for other work to be connected to that in progress, it may lead to serious errors.

For railroad purposes the land is usually found in long narrow strips of varying width; and it is sufficient to find the length on the centre line, and directions of bounding lines which cross; it is however, desirable to have all "land lines" within four or five hundred feet of the track, and this requires measurements on the crossing lines. In getting the direction of a fence, when the instrument is placed at one side measure the distance from the instrument to the fence at right angles to it, and have a similar "offset" made as far as possible from the instrument; of course the main line should have been run and the transit placed in the line before the direction can be obtained.

For street surveying the best method is that of a line in the middle with offsets and measurements connecting the offsets at the ends as well as the line run, this was published in the "ENGINEERING NEWS" a few weeks ago, and we most heartily endorse the writers views and testify that our experlence,—and we have used it many times—has always been satisfactory. In very crowded streets we have sometimes run a line down each footwalk, connected them carefully at their ends, and then proceeded as described for a single line.

In all work of this kind the most important thing is to take good notes; always put these down as if you expected to die before morning, and wanted to leave them in such good condition that in ten years time a stranger with no previous acquaintance, and with no one of the old party to help him, could take your book and proceed on the job without delay; if this can be done your notes must be about right, but you never will have them too complete. We have never used any but the "sketch system" for keeping notes, and we always made them in the field, and copied them over on the next page in ink, thus keeping the rough set with the original figures, and the finished set to explain them; the original figures have more weight as evidence, but the explanation given by a neat ink copy is a very great help in interpreting them. For city work take all angles with the transit more than once, that is to say, "repeat them," three or four times which is enough; the object of the "repeating" being to check the ang'e and not to subdivide the vernier reading.

After the completion of the land survey comes the actual field work preparatory to the construction, and here it is customary to reduce the number of men in the party and to begin to "cut down expenses" in the engineering department.

The first thing to be done is to "preserve" the line, that is to connect all tangent points with stakes that are away from the line and far enough from it not to be disturbed by the operations of grading and earthwork; at the same time the slope stakes should be set and marked with the cut and fill—also the cut or fill should be marked on the centre stakes—this work can all be done on the same job and thus the contractors can make a start at once if they so wish; of course a record of all field work is required and the results should all be put in the grade book. For setting slope stakes the only satisfactory method is with the Levelling Instrument, though for comparatively smooth ground and light work, there are various devices for setting slopes which involve much less work, and are sufficiently accurate for use.

Most of the work for railroads in construction consists in setting "centres" and "grades;" for the former in nine cases out of ten, the line can be run in without an instrument, if the known points are convenient; the Tangent Deflections are useful for running curves with only the chain and rods for lining; for approximation there is a very convenient method of computing angles and distances (measured as arcs) which it is well to be familiar within the absence of all "pocket books." At one hundred feet distance three hundredths of one foot subtends one minute of arc. Strictly speaking it is twenty nine one thousandths instead of three one hundredths. At the same distance one foot and three quarters subtends one degree of arc, but one and eight tenths can generally be used. With this once fixed firmly in mind mental computations can be made with the greatest ease. As an example of this let it be required to find Tangent and Chord Deflection for 100′ chord, and for 60′ chord, and ordinate at centre of 100′ chord for a 5° curve: $5\times1.8=9.00°$ for the Chord Deflection, and 4.5′ for the Tangent Deflection 100′ chords: $4.5\times0.6=2.7'$-$2.7\times0.6=1.62$ Tangent Deflection for the 60′ chord, and ¼ of the Tangent Deflection for 100′ chord = 1⅛′ for the middle ordinate. These values are all in excess, and if the deflections are to be used for running the curve more than one station, the value $1\frac{1}{8}'\times5=8\frac{1}{4}'$ should be used and this is in error only about ⅜ of one inch. A great many other computations may be thus performed mentally and the work already done, checked by these approximations, and the real blunders found.

There are many ways of doing most kinds of field work, and many methods are described in the books under various heads—but a good knowledge of geometry and trigonometry, and possibly a little familiarity with analytic geometry combined with a cool head, and an appreciation of the external circumstances, will enable a man, after a limited experience to become competent to take charge of a party in the field, as far as the mere theory of the operations are concerned—but a knowledge of human nature, and sound judgment are required to give satisfactory results.

We would say a word about the staking out of culverts and masonry, and will begin with a hint about box culverts. On masonry of this class it is well to put in four stakes on the lines of the face of each wall, one at each end of each line, and two stakes, one at each end of a line terminating the culvert at the proper distance out, found as in slope stakes. These stakes must all be placed outside of the trenches, and should be at such a distance from the work that they will be safe during the construction.

Bridge abutments on shore can be given in the same way, and if in the water by parallel lines, or sighting frames made out of strips of wood. Piers can be located by sights on shore or as they are commonly termed "ranges."

If earthwork is to be measured in a "borrow pit," the best way is to run out two sets of lines at right angles over the ground, denoting distances in one direction by letters, and in the other direction by numbers, and taking the levels all over the ground denoting the stake by both letter and number, and then every month as the work is done, these stakes can be replaced and the levels taken again. The bounding lines of this system should be carefully put in and the stakes may have permanent "sights" put up over them, in this case the stakes of the system can be replaced without a transit. Of course the bounding lines should be wholly outside the work and there can be little trouble in taking care of the work in this way.

Retaining walls are very usually set out by stakes, but "sighting frames" outside the wall and in line with it are to be preferred, if the hight is not too great.

Underground work in tunnels is usually kept in line and grade by points on the roof; their stability and permanence are much greater than if given on the bottom

of the tunnel. In rock work where stakes can not be used, chisel marks are made to serve as points. Such work requires less frequent attention, but is more important.

And now in closing, lel us add a word as to the responsibility resting upon the engineer when setting out work.

Few beginners appreciate the necessity for correct work, and do not realize that a blunder undetected may cause a loss to the contractor of a great deal of money, and that if he, as the company's authorized agent, makes a mistake in his work, the company may become liable for many times his salary, and that his discharge is a very small amelioration of matters which he has mixed up. Pecuniary Responsibility must be fully appreciated in order to have accurate work done.

Mistakes in work are not only discreditable but they are dishonorable, and to the feelings of the suffering party they seem criminal. Now, as man is liable to error, work must always be in some way checked, and a mistake which is discovered by the maker in time to be rectified by him before any damage is done is in no way discreditable, provided however that it does not happen too often, and that the same class of mistake is not made the second time. Nothing gives a contractor less respect for the engineer than finding his mistakes, even if they have caused no damage. S.

The Dimensions of Narrow Gauge Railroads.

BY GEORGE PAUL, C. E.

CHAPTER III.

Grades of a road intended for light traffic, and built through an ordinarily level country, may be nearly surface grades, requiring but light cuts and low embankments—sufficient only, to provide suitable drainage; but where a heavy traffic is anticipated, care should be taken to reduce the ruling gradient to the lowest point deemed practicable. With this once established, there is but little objection to introducing it again, especially for short distances, inasmuch as the train cannot be greater than the locomotive can haul upon this; but if once made up for a certain grade, it should be able to haul the train over one or more. Where the grade is below the angle of friction 18 to 20 feet per mile, it presents a very slight objection, in our estimation, as it is not neccessary to use the brakes or shut the steam entirely from the cylinders.

The resistances to be overcome in hauling a train are as follows:

First resistance from friction.
Second " " atmosphere.
Third " " gravity.

The first is friction of wheels on rail and axles in journals, and is generally estimated at 6 lbs. per ton per train, and 6 to 8 lbs. per ton for locomotive and train.

The second is resistance caused by atmosphere. This is very variable under ordinary circumstances. a great difference being made by the state of the atmosphere, whether at rest or in motion; also, its relative direction with the train and the velocity of the train. The rules given by D. K. Clark to determine the resistance due to the atmosphere are as follows, showing that it increases with the speed:

RULE 7. To find the total resistance of the engine, tender and train, at a given speed: Square the speed in miles per hour; divide by 171, and add 8 to the quotient. The result is the total resistance in pounds per town weight at the rails.

RULE 8. To find resistance of a train alone, at a given speed: Square the speed in miles per hour; divide by 240, and add 6 to the quotient; the result is the resistance at the rails in pounds per ton weight.

The 6 and 8 pounds to be added above are due to friction. For net tons we use one pound less. The third cause of resistance mentioned is that due to hauling the train upon an incline, or grade. This is called resistance due to gravity, and is directly as the hight raised is to the horizontal distance traveled.

To find the resistance due to gravity in pounds per ton of 2,000 pounds:

RULE 9. First, multiply rise in feet per station by 2,000; divide by length of station in feet.

RULE 10. Second, multiply rise in feet per mile by 2.64.

Example—Rule 9: Where rise per station is one foot or 52.8 feet per mile, 1×2,000÷100 ft. length of station=20.00.

Example—Rule 10: 52.8×2.54=20.

Example—Rule 7: Speed 12 miles per hour, 12×12÷171=0.84.

In order to find the total resistance in pounds per ton upon a straight line, we take the sum of the amounts found by Rules 7 and 9 or 10. Where the grade is 52.8 feet per mile the following is the resistance at the speed of 12 miles per hour:

Resistance due to speed, 12×12÷171=0.84	lbs.	℔ ton.
" " friction,	7.00	"
" " gravity, 52.8×2.64	20.00	"
Total,	27.84	"

When it is intended to establish a maximum gradient, it is understood that the resistance due to it shall also be the maximum when upon a straight line; consequently if curvature should be introduced, it will be necessary to reduce the gradient to such an extent that the greatest resistance will not exceed that of the maximum upon a straight line.

To find highest grade that can be established upon a curve in order that the maximum resistance will not exceed that upon a maximum grade:

RULE 11. Subtract resistance due to curvature from resistance due to maximum grade; multiply by 2.64.

Example: Curve 3 degrees; maximum grade 52.8 feet per mile.

Resistance due to gravity (Rule 9)	20	lbs. per ton.
" curvature (Table of curve)	0.81	" "
	19.19	
Multiply by	2.64	
	7676	
	11514	
	3838	
Feet per mile	50.6616	

There are many instances in which the traffic is greater in one direction than in the other. This is the case on the lines of road leading from Chicago eastward, to a marked extent, and is so to a still greater extent upon roads designed for a mineral traffic, as their cars in almost every instance return to the mines empty. Under these circumstances the grades in the direction of the lighter traffic may be higher than in the other direction. This would reduce the cost of earthwork to a certain extent. If such a course should be decided upon, the following is the rule for finding a gradient corresponding to the lighter traffic, when the per cent. of the total tonnage (including weight of locomotives and train) in the direction of the largest freights is in excess of a corresponding tonnage in the other direction:

RULE 12. To total resistance per ton upon the established grade in the direction of the heavier freights, add the same percentage that the greater tonnage exceeds the lesser; subtract resistance due to friction and speed; multiply the remainder by 2.64.

Example: When estimated tonnage eastward is 1,636 tons, including total weight of locomotive, tender, cars and freight, and 1,090 tons for the same in a westerly direction, grade 52.8 feet per mile, speed 12 miles per hour, resistance from friction 7 lbs. per ton,—total resistance per ton upon established grade:

Gravity	20	pounds.
Friction	7	"
Speed	0.84	"
Per ton	27.84	"

Eastward tonnage in excess of western, 1,636+1,090 =50 per cent.

Resistance per ton,	27.84	
Add 50 per cent,	13.92	
	41.76	
Subtract friction and speed,	7.84	
	33.92	
Multiyly by 264,	2.64	
	13568	
	20352	
	6784	
Grade in feet per mile,	89.5488	

to correspond upon a freight basis with 52.8 in the other direction.

By this rule the advantages of a light rolling stock over a heavier one may be determined, or the saving in gradation, by permitting a steeper gradient. For example: In this instance we will suppose a saving of 10 tons per train can be effected by the the use of lighter rolling stock, and the weight of the train is 110 tons with heavy and 100 tons with light rolling stock; speed 20 miles per hour:

Resistance due to gravity, speed and friction	27.84	lbs. ℔ ton.
Add 10 per cent., which is excess of greater tonnage	2.784	
	30.624	
Subtract resistance due to friction and speed	7.84	
	22.78	
Multiply by 2.64,	2.64	
	9112	
	13668	
	4556	
Grade for light train, which requires same power of locomotive	60.1392.	

—*Railway Review.*

Manufacturing Notes.

The buildings of the Tennesse Iron and Steel Company, of Chattanooga, Tenn., are completed, and the machinery is being set up.

The Boston Navy Yard is making several five-inch steel wire hawsers to replace the twelve-inch hawser formerly in use for towing monitors and vessels in distress.

The Columbus Sewer Pipe Company manufacture about $100,000 worth of sewer pipe annually; they employ forty men, and occupy about fifteen acres of grounds with their works and yards. They find a market in the West and South.

Last week nearly 600 men were discharged from the Baldwin Locomotive works, of Philadelphia. They are principally men who were taken on last winter, their pay ranging from $8 to $14 a week. The superintendent of the works, however, says that the prospects for engine-work in the fall are very good, and that most of the men who have been discharged will probably be put to work again. The reduction in force will reduce the expenses of the works nearly $10,000 a week.

The agent of the Fall River Manufacturers who was sent to South America several months ago to open a market for American fabrics sends home most encouraging reports of the success of his negotiations, and is sanguine that a large trade can be established. The aggregate exports of cotton goods for 1874 from the United States to the six principal States in South America were only $2,264,000; while Great Britian shipped them nearly $39,000,000, and France within a fraction of $3,000,000. If American print-cloths can be exported to England and sold at a small profit, manufacturers can certainly find a market in South America.

Bids received for the construction of the Nicollet street sewer, Minneopalis, were as follows:

Henry & Abrams	$5,353 25
Nicols & Watson	5,644 63
R. M. Douglass	5,341 98
Winston Brothers	4,767 21

The length of the proposed sewer from High street to Washington auenue, including man-holes and catch basins, is 1,127 feet, and the bid of Winston Brothers is $4.23 per lineal foot.

Contracts were let by the Board of Public Work, on Aug. 23d, at Milwaukee, Wis., for work on Seventeenth street, from Spring to Cedar street: Grading to A. Gulkneet at 14 cents; planking at 19½ cents. Gravelling to H. Studeman at 85 cents; paving at 40 cents. For a branch police station and truck house in the Fifth ward. Lowest bid, Jacob Herr, $8,550; bid to be submitted to Common Council. For work on Van Buren street, Seventh ward: Grading to E. Collingbourne at 24 cents; paving to P. Drew at 64 cents; curbing to F. L. Tebel at 9 cents? sodding to P. Rooney at 10 cents.

The Erie Railway has been served with notice by the Attorney General of Pennsylvania, to rebuild the bridge connecting Port Jervis, N. Y., with Matamoras, Pa. This bridge was blown down eight years ago and James Fisk, Jr., obtained legislation to release the company from obligation to rebuild. This legislation has proved void and Erie must maintain the bridge for the privilege of running through Pennsylvania. The Lehigh and Eastern intend to use this bridge to enter the state of N. Y., and connect with the Erie at Grey Court on the Newburg branch to the Hudson. Ground was broken on Aug. 24, between Matamoras and Milford and the road is to be completed by April 1st, 1877. It will be 100 miles in length and is to extend from Tomhicken, Pa., on the Dansville, Hazleton & Wilkes Barre R. R, to the point on the Erie, mentioned. It is essentially a coal line for the benefit of New England.

Contractors' Intelligence.

The contract for the granite curbing to the grounds of the City Hall, Holyoke, Mass., has been awarded to Blevins & Marar.

The Detroit News says that "the worst bridge in Michigan, is at Cheboygan." That is a mistake, Charlevoix disputes that honor.

In order to conduct the water main up Julien avenue, Dubuque, Iowa, it is necesssary to blast a passage six feet deep through solid rock.

The new water works tunnel at Cleveland, is so far completed that the main connections with the lake tunnel will be made this week.

A contract for $295,000 has been awarded for constructing the 26 miles of the Simcoe Junction Railway between Stouffville and Jackson's Point on Lake Simcoe.

The bids for the erection of the addition to the state normal school building in Oshkosh, Wis., were opened Aug. 22; the contract will be awarded to Bell & Rogers, of that city. There were twelve bidders.

The Erie City Iron Works of Cleveland, have secured a contract for manufacturing fifteen boilers, of fifty-horse power capacity, to be used for pumping at the different stations on the mammoth pipe line from the Oil Regions.

The La Crosse *Democrat* says that, on the 18th, one hundred and fifty men quit work on the La Crosse extension of the Green Bay road, because the contractors C. C. Smith & Co., reduced wages from $1.75 to $1.50 per day.

The people of Redwood City, Cal., are wrestling with the water question. An election has been called for the purpose of voting $22,000 for the construction of water works, it being proposed to sink artesian wells and raise the water by steam.

The new pier N. R., at the Battery, N. Y., is the only pier which is being constructed entirely of stone and concrete masonry. It is 452 feet in length, by 80 feet in width, and will be finished this year, five years after the work was commenced.

The commission to pave Pennsylvania avenue, Washington, D. C., have appointed Mr. John A. Partridge, of that city, general superintendent of paving at $150 per month, and Mr. D. W. Bailey, of Hingham, Mass., foreman of asphalt work at $4 per day.

Quite a number of contractors have been over the proposed line of the Menominee Range R. R., (Wis.) within the past few days, and everything seems to indicate that work will be commenced on it very soon, though, it will probably not be continued past the Breen Mine this season.

The lowest tender for the contract to construct the Cornwall Canal improvements, is that of Gordon & Co., of Sherbrooke, in which Mr. Brooks, of Brockville, is interested. In case satisfactory securities are furnished, the contract will be awarded to that firm. Their figures slightly exceed $400,000.

The Brighton, Mass., high-service reservoir has a capacity of 47,400,000 gallons. About four miles of high-service pipe have been laid. The pumps, which were made by Henry R. Worthington, of New York, are of the duplex high pressure pattern, each having a capacity for pumping 400,000 gallons of water per day.

A vote was taken at Davenport, Iowa, Aug. 27, on the proposition of voting a nine-mill tax to aid the completion of the Davenport and Northwestern railroad, from the present terminus, three miles north, into this city, and it was carried by an overwhelming majority. Five hundred men and teams will be at work within 10 days on the road. Everybody is happy.

The following bridges were washed away near Wheeling, W. Va., in a recent storm: The county bridge at Burlington; a bridge on the Bethany pike; the county bridge at Jack Acheson's place, on the Virginia side of the river above the city, and most all the bridges between Wheeling and Short Creek; the county bridge over Deep Run is gone, also the railroad bridge, but the latter has been replaced since the storm.

Work on dam No. 9, which is being constructed on the Monongahela, seven miles below Morgantown, W. Va., is being pushed forward. The lock has been completed, except hanging the gates, and work is progressing on the foundation for the dam, which will be constructed of solid masonry. The intention is to go down to solid rock for a foundation, and it is expected that the work will require three months longer.

The masonry work on the five new bridges to be built in Dubuque county was awarded August 25th by the board of supervisors as follows: Schemmel Factory bridge in New Wine township, to Peter Mehl, at $235; Miller bridge, in Washington township, Thomas Cavanaugh, $594. To the latter person also Ball bridge, Center township, $674, and Black bridge, New Wine township, $844. The contracts for five iron bridge superstructures were let to King & Wheelock for the King Bridge Co.

Improvement of the Mouth of the Mississippi River.

A paper read before the American Society of Civil Engineers, by E. L. Corthell, C. E., Chief Assistant Engineer South Pass Jetty Works.

In the discussion of this subject, it may be of interest to state that this day, one year ago, work was commenced on the South Pass jetties. The contractor, James Andrews, of Alleghany City, Pa., arrived the day before with a stern wheel steamboat, a pile driver, and a few workmen. They landed among the reeds, and broke down the tall grass along the banks to find a place for their anchor in the soft mud. There was no house, but the light-house, within several miles, and with swarms of mosquetoes and sand flies, and the oppressive heat, the commencement of the work was anything but auspicious. On June 15th, the first pile was driven for the wharf at Lands End, and the work of preparation and of actual construction went forward rapidly.

It is my privilege to give you the results that have been reached in the first twelve months intervening between that day and this. I am glad to find, by personal conversation with members, that there is a very great interest in this work, and as the generally expressed wish is for facts, I will confine myself to them entirely, and leave the question with you, as to whether they are favorable or otherwise to the ultimate success of the jetties. Having been the engineer in charge, my peculiar work has brought me into contact with facts and actual conditions, and the rapid progress of the work, with the consequent arduous field and office duties, have given me but little time to analyze or theorize on the facts brought daily under my notice.

Considering the fact that this question of jetty construction, as applied to the mouth of the Mississippi has been discussed fully, not only in engineering circles, but also by the general press of the country, and in pamphlets and Congressional papers, until the nation, as a whole, is familiar with the various theories advanced to prove and disprove the success of the enterprise; it is not my place to weary you with a discussion of theories, but I will proceed at once, after a brief explanation of the work to be done, to present what facts I have.

The Mississippi river, when within about twelve miles of the Gulf separates into three rivers or passes, and thus forms the Delta. The three passes are A'Loutre, South and South-West. The South Pass is the smallest of the three, though the central one. The volume of water carried to the Gulf through it, is but 12 per cent. of the whole volume of the river. South West Pass carries about 58 per cent., and Pass A'Loutre, with the smaller passes flowing out of it, carries the remainder.

A shoal bar exists at the mouth of each of these three passes, the depth of water on each varying generally in proportion to the volume carried to the Gulf over it. This bar is composed entirely of sedimentary matter brought down by the river. The water issuing from the passes, no longer confined by banks, spreads out on either side. The velocity diminishes, the sediment drops, the bar forms. The central thread of the current being the strongest, and the water being the deepest there, the velocity is preserved and the sediment carried out much further than in the shoal water over the submerged new banks of the pass. The outer crest of the bar is thus thrown out 2¼ miles from the land's end at the South Pass, and 5 miles at the South-West Pass. The depth on the bar at the former pass is 7½ feet at mean low tide, and at the latter pass, 15 feet.

The principle to be applied to deepen the channel through the bar was a concentration of the volume by means of parallel jetties or dykes. Whether its application will be likely to produce the required depth, viz.: from 20 to 30 feet below average flood tide, you can judge from the facts to be presented.

It was doubted by some whether the material composing the bar, being freshly deposited, would have sufficient solidity to uphold works of the requisite weight and strength to resist the servitudes of storm, waves and river currents. The following table will give a better idea of the character of the jetty foundation than any description.

TABLE I.

Showing Character of Foundation of Jetties from Record of Pile Driving.

Piles from 8 to 20 feet apart. Distances in Tables are from Lands End, East side; piles 10 inches at small end and 14 inches at large end.

Location of Piles	Weight of Hammer	Average fall of Hammer.	Average of Blows.	Average depth Driven.
East Jetty.	Pounds.	Feet.	Number.	Feet.
From 4,200 to 5,500 ft	3 000	15.5	44.0	16.7
" 7,200 to 12,100 "				
" 9,100 to 9,300 "	3 000	18.6	98.0	17.4
" 11,900 to 12,100 "	3 000	19.0	45.0	28.2
West Jetty.—Whole length of same.	3 000	19.5	79.7	19.5

Analysis of number of blows for different depths on west jetty; approximate—

Number of blows first 5 feet driven,	4,	or 15 inches per blow	
" " " next 6 " "	20,	or 3.6	" " "
" " " " 4½ " "	20,	or 2.7	" " "
" " " last 4 " "	35.7,	or 1.3	" " "

Average distance driven at last blow, ¾ inch.

It will be seen from Table I, that at about 9,300 feet on the east jetty, the material is much harder than elsewhere, and the detailed record of the pile driving on the west jetty shows the same material to exist there, at the same distance. The channel on the line of this hard material resisted much longer than that of any other locality the excavating power of the current.

The following table illustrates the progressive deepening towards the outer bar. The contours refer to the plane of average flood tide as established by Maj. C. B. Comstock, who is inspector of the work for the United States government. The distances in all the tables are from a common zero point at Land's End at the commencement of the east jetty, and from a triangulation station named East Point, established by Mr. Marindan of the U. S. Coast Survey, whose charts, made from a survey terminating in May, 1875, are the basis on which our location was made, and which we still use for comparative purposes.

No record of the 22 and 24 feet contours was made prior to March 29, 1876.

TABLE II.

Record of Distances in Feet through the Bar between the Contour Lines.

Which Contour.	May 1875.	Dec. 1875.	Jan'y 1876.	Feb'y 1876.	Mar. 17, 1876.	Mar. 29, 1876.	April 1876.	May 1876.	July 30, 1876.
12 Ft	4 305	2 635	750	0	0	0	0	0	0
15 "	5 925	4 400	4 175	2 175	450	50	0	0	0
18 "	7 000	5 692	4 480	3 900	2 575	1 180	750	175	0
20 "	9 035	6 215	5 425	4 490	3 255	2 955	2 200	720	75
22 "	.....	.....	.....	.....	.....	5 270	3 995	1 952	1 350
24 "	.....	.....	.....	.....	.....	7 600	5 975	3 120	2 750

These distances embrace all portions of the bar that rise above the contours between the 35 feet depth at Land's End and the deep water outside the bar. The progressive reduction in the size of the bar is generally in comparison with the progress of the jetties, especially at the earlier dates. The surveys from which this and tables following are compiled are made in the most thorough manner, and with no effort spared to render the surveys accurate and the result reliable.

The deepening has been affected by the operation of the river current and by the tides, although the latter in this portion of the Gulf are diurnal and feeble, having an oscillation of 22 inches only, between mean low water and mean high water, yet at the season of highest and lowest tides the scouring power of the current is considerably augmented.

Tables III, IV show the progressive depths in the line of deepest water. It will be noticed by an examination of these tables, that there are irregularities in the progressive depths and widths, all of which explain themselves. It will be noticed thatthe attempts of the concentrated volume to excavate a channel were peculiar and at times spasmodic, that a

TABLE III.

Depths (comparative) in Line of Deepest Water, in Feet.

Distances from East Point	May 1875.	Dec. 1875.	Jan'y. 1876.	Feb. 1876.	Marc. 1876.	April 1876.	May 1876.	June 1876.	July 1876
E. P't.	31.8	37.0	37.0	38.0	38.7	38.0	37.5	37.1	37.1
1 000	31.0	28.3	28.0	28.0	28.0	28.0	28.5	28.7	29.0
2 000	21.8	22.8	23.0	23.0	23.2	25.0	23.9	24.0	25.0
3 000	18.8	22.5	22.0	21.8	21.2	22.3	21.4	21.9	21.6
3 500	18.0	20.0	20.0	20.0	20.2	21.8	21.4	21.9	21.1
4 000	18.0	22.3	22.4	22.5	27.4	28.8	37.9	38.5	39.5
4 500	18.0	23.3	22.9	23.5	22.9	23.3	21.5	23.3	30.3
5 000	17.7	23.0	21.4	28.5	25.4	27.1	28.0	28.2	30.3
5 500	16.0	19.8	21.4	23.3	24.9	25.1	27.0	25.5	26.8
6 000	14.3	18.8	22.2	22.6	25.4	38.4	30.6	29.1	27.3
6 600	14.0	16.2	18.1	17.2	23.2	24.2	28.1	30.1	26.8
7 000	13.0	15.6	20.1	24.5	23.4	24.0	24.4	26.0	26.0
7 484	11.8	13.5	14.0	24.0	22.5	21.8	24.7	27.4	24.9
8 000	11.0	13.0	14.1	18.0	18.0	22.4	26.9	28.3	26.4
8 200	11.0	13.0	14.5	18.0	18.2	28.0	32.4	30.3	28.9
8 500	10.9	13.3	13.1	15.0	20.4	23.2	25.8	27.6	23.9
9 000	10.5	11.8	13.0	15.0	18.0	23.2	21.9	26.8	27.9
9 500	10.8	10.8	11.0	13.0	17.4	20.3	47.3	45.0	38.8
9 900	10.0	11.0	12.6	14.0	16.0	22.8	33.9	34.0	42.8
10 500	9.5	9.3	12.0	16.6	18.7	19.8	32.7	33.0	39.8
11 000	9.2	9.8	12.0	14.6	18.0	19.2	24.5	26.2	28.3
11 500	9.2	11.3	12.0	15.0	15.9	18.2	22.7	21.5	20.8
11 700	9.2	16.8	17.0	18.0	15.0	17.0	18.0	21.0	22.4
11 900	11.8	15.0	18.0	18.5	19.0	18.0	16.5	18.3	22.8
12 000	20.8	40.8	34.2	13.2	20.8	23.0	30.2	30.5	20.0
12 400	31.0	40.0	35.0	30.0	47.0	42.3	25.0	20.0	22.8
12 800	35.0	....	....	....	....	....	....	....	41.8

desperate attempt to deepen the channel would result in a channel too deep for the necessities of the case, and a widening taking place soon after, the depth would become less. It may be taken as a general fact that an unusual and extraordinary deepening would result in a widening and a subsequent shoaling, and that a narrowing out of the channel would indicate a deepening.

The peculiar condition of the work also tended to produce irregularities; for instance, when the dam connecting the upper end of the west jetty with the shore was built, there was a head of water produced against it, extending to the east jetty, but diminishing as it ap-

TABLE IV.

Record of Width in Feet, of Channel at a Depth of 20 Feet, on the Established Cross Sections and at different Dates.

A dash in the columns, denotes less than 20 feet depth at the date where it occurs.

Location of Cross Section.	May 1875.	Dec. 1875.	Jan'y 1876.	Feb'y 1876.	Mar. 1876.	April 1876.	May 1876.	June 1876.	July 1876
E. P't.	408	553	553	493	500	520	530	540	540
1 200	430	470	470	441	460	460	450	440	440
2 200	230	492	492	480	433	470	430	410	465
3 000	—	345	345	312	300	470	410	350	470
3 500	—	300	300	220	285	480	470	300	200
4 000	—	30	305	312	360	362	340	380	370
4 500	—	110	260	165	300	345	343	300	290
5 000	—	—	305	167	165	205	202	140	170
5 500	—	—	165	207	184	205	266	205	225
6 000	—	—	82	75	122	212	308	340	450
6 612	—	—	—	65	190	280	338	315	350
7 125	—	—	10	215	210	326	340	320	370
7 584	—	—	—	145	155	260	330	340	390
8 000	—	—	—	17	118	192	308	350	345
8 500	—	—	—	—	—	90	338	340	395
9 000	—	—	—	—	—	64	295	350	380
9 300	—	—	—	—	—	—	105	270	410
9 900	—	—	—	—	25	38	203	300	360
10 500	—	—	—	—	—	—	300	280	385
11 000	—	—	—	—	—	—	208	340	400
11 500	—	—	—	—	—	—	100	120	335
12 100	400	1000	640	320	868	—	217	200	385

proached the latter. This condition produced quickly a deep channel below the line of the dam, and the channel above the dam had a tendency to shoal slightly, caused by the reduction of velocity which the head of the water had produced.

The deep channel immediately below the line of the dam caused a temporary shoaling at a point about 500 feet below the dam, as the velocity for the first 300 feet was too great to be maintained. A comparison of the bottom velocities above and below the dam, as ascertained immediately after its closure, will further illustrate the subject. The dam is located 4,000 feet from East point, and nearly at right angles to the jetty lines. Above 4,000 feet, the velocity was 2.2 feet per second, from 4,000 feet to 4,500 feet, 2.86 per second, and from 4,500 to 5,000 feet, 2. 31 per second.

The varying conditions of the river and the amount of sediment carried in suspension, the difference in the material composing the bar at various places, the state of the tides, the direction and force of the winds, the storms and resulting seas that rolled in against the current, the conditions of the works at Grand Bayou and at the head of the pass, the state of the jetties especially—all conspired to render the work of channel excavation irregular, but taking the general progress into account the advance in depth and width has been constant and steady, and the effect of the jetty construction has shown that the volume of water issuing from the pass will eventually recover the section it has normally above.

A dam has been thrown across Grand Bayou, and above 90 per cent. of its volume turned into the pass. It is reasonable to expect that the section between Grand Bayou and the sea end of the jetties will enlarge until it is as large as that above Grand Bayou or to an ultimate section of 25,000 square feet, it now being 15,000 square feet. (Reference is made to table V, following.) It is also reasonable to expect that the section between the jetties will finally be larger than the section above Grand Bayou, as a larger volume will necessarily flow between the jetties during the ebb of the tides than flows through the pass above Grand Bayou, as the range of the tide is greater and the slope steeper near the gulf than it is 8 miles above.

TABLE V.

Comparative Areas of Sections of South Pass.

Location of Section.	Plane of Reference.	Area in Sq. Feet.	Date of Survey.
One mile below Head of Pass..	Mean high water.....	24 395.0	U. S. Coast Survey, May, 1875. Jetty Eng'rs, Aug. 2d, 1876.
	of U. S. Coast Survey,	25 057.3	
3 600 feet above Bayou Grande..	Mean high water.....	23 243.0	U. S. Coast Survey, May, 1875. Jetty Eng'rs, May, 17, 1876.
	of U. S. Coast Survey,	26 037.0	
South Pass Light House.....	Average flood tide.....	16 711.0	U. S. Coast Survey, May, 1875. Jetty Eng'rs, July, 30, 1876.
	of U. S. Engineer's	17 006.0	
5 500 beyond Lands End and between the Jetties; present depth, maximum 27 feet....	Average flood tide.....	14 804.0	Jetty Eng'rs, July 30, 1876.
	of U. S. Engineer's....	.....	.....

But the facts relative to final sections and volumes and velocities during the formative state of the channel through the bar and the reformative state of the pass between Grand Bayou and the mouth cannot be obtained at present. All the old natural conditions of the pass, from its head to the gulf, and far beyond the sea ends of the jetties have been disturbed by the construction of the auxiliary works, especially those at the head of the pass which are intended to deepen the shoal at that point. When the whole work is finished and the normal condition of the pass restored by time, there will be very many interesting and valuable facts which no doubt will be given you.

A very important question and one that cannot be definitely determined by facts until the completion of the jetties, is that of an accelerated bar advance due to the construction of the jetties. All that we can state now, bearing on this question is, that although there has been a pushing outward of the upper part of the outer slope of the bar, due to three or more temporary causes; *first*, the impossibility of constructing the whole line of jetties instantaneously; *second*, the large amount of material excavated and carried out to sea; *third*, the closing of Grand Bayou and a new load of sediment given the water in addition to its already heavy burden; and *fourth*, the non-completion of sea ends of the jetties to a point designated by the Advisory Board of Engineers, who assisted Capt. Eads in determining the plans for construction; yet careful surveys and calculations show a deepening instead of a shoaling immediately in front of the sea ends of the jetties. The water prism extending seaward from the old crest of the bar, and covering an area of 52 acres, has increased from 2,000,000 cubic yards to 2,200,000 cubic yards, or, in other words, the average deepening over the whole area investigated is 2½ feet. The survey on which the calculations were based was made May 29th last. A survey by radial lines of soundings, extending five miles out from the jetties, made in May by Mr. H. L. Marindan of the U. S. Coast Survey, shows by comparison with the chart of the Survey of May, 1875, made by him, that there has been an average deepening of the whole area surveyed.

The volume of the bar removed during the first year of the work, without reference to the amount moved in the channel as required by law, or, in other words, the total excavation exceeds 3,000,000 cubic yards. The following table shows the volume of the bar moved in reference to a channel 20 feet deep and 200 feet wide at that depth.

The results are obtained by placing on the cross sections drawn on profile paper, a normal section as we find it in the pass above the jetties. This section has a center depth of 2 feet below the 20 feet line and side slopes of 1 foot vertical to 20 horizontal. This normal section is made on tracing paper, then placed over the cross sections and the area is thus obtained for the calculation, as to the volume to be moved to make a channel of the normal section as described.

TABLE VI.

Volume in cubic Yards of the Bar removed in Reference to a 20 Feet Channel.

Date of Survey.	Volume to be Moved.	Vol. Moved.
May, 1875.....	1 037 635	.....
Dec. 25, "	622 680	414 955
Jan'y 27, 1876.....	524 909	97 771
" 31, "	506 643	18 266
Feb'y 17, "	499 715	6 928
Mar'h 4, "	395 547	105 168
" 25, "	256 655	48 882
Apail 25, "	163 619	93 036
May 29, "	22 627	140 992
June 30, "	13 997	8 650
July 31, "	4 985	8 992

A part of the material has fallen over the submerged jetties during their construction, or has been driven in by the waves from beyond the sea end of the jetties and lodged on their sea slopes. 1,000,000 cubic yards, at least, have piled themselves up against the sea side of the jetties, an enduring and solid bulwark against the storms. The remainder has gone far to the westward, no doubt carried there by the prevailing westward coastwise current.

The so called "littoral current," is a current generally existing and has a westward course. Whether it is caused principally by the prevailing northeast winds or by a more constant and stronger influence, is somewhat doubtful. We have strong evidence from an examination of the general formation of the coast of Louisiana and Texas, from the eastward bend of the lower river towards that direction, by the excess of accumulation of sediment and subsequent shore formation westward, from the general opinion of longshoremen and pilots and from our own observations, that there is a distinct and constant and deep moving, westward, littoral or coastwise current, strong enough to remove far from the mouth of our new channel the sediment carried out by the river, and which will postpone for a century or two the re-formation of the bar.

In regard to action of Gulf storms upon the work, I will state that during a severe storm on March 5th, which continued several days, a few mattresses on the sea end of the west jetty were destroyed, but the work had not been consolidated nor sufficiently covered with stone. The plan of final construction provides for jetty heads of enormous base, easy slopes and a covering of heavy stone. From the experience had, we have no doubt of the ultimate stability of all parts of the work, both in reference to Gulf storms and the river currents.

The facts given and the tables and sections exhibited are the result of careful surveys and faithful office work. Extended and often repeated surveys have been needed to inform us of the progress of the works and the results they are constantly accomplishing, and often so rapidly that our surveys could not keep pace with them.

The paper under discussion gives us the pivotal fact, which guarantees the success of the jetties, that the deep water of the pass follows close behind the bar in its seaward march. Examine the tables presented and you will see that this fact is clearly and forcibly illustrated. It may be said, truthfully, that twelve months of work and its accompanying results have proved every theory advanced and every prophecy made in that paper. It and this account—one presented af the commencement, the other, one year after the beginning of the work—are substantially the same, the latter being simply illustrative of the other.

NOTE—There was 21 feet of water through South Pass bar, August 15th, 1876.

ENGINEERING SOCIETIES.

The present is a favorable opportunity to call attention to the lists of members of the various engineering societies which we have published during the summer months. Anyone who takes the pains to run over these lists of the American Society of Engineers, the Institute of Mining Engineers, the Civil Engineers' Club of the Northwest, and the St. Louis Society, will be struck by the great number of prominent professional men connected with them, and the great power that any, or all these societies, as a whole, could exert in shaping questions of scientific moment and in influencing public opinion. Many instances of this kind have already occurred in the American Society of Engineers, the most prominent and generally beneficial being that of the Board for Testing Metals, which was brought before Congress by one of their committees.

The summer vacation is essentially over and the various society meetings will soon be resumed, and along with the professional papers and their discussion one or two other subjects should be considered. We refer to the technical education of engineers or what restriction can be imposed on incompetent practitioners, and the present social status of the profession. The first question has already been opened before two of our leading societies, but, although the symptoms are too plain to be mistaken, the disease has assumed something of the chronic type in which its progress is so slow that engineers are loth to apply the remedy, even if the remedy be clearly seen, which is somewhat doubtful. It is a subject needing constitutional treatment, and about which we can afford to make haste slowly, but one nevertheless deserving of immediate and careful consideration.

There is no doubt but that the status of the profession has risen, and is rising in this country. While this naturally seems encouraging, there is again no doubt that it has failed to hold its relative position in regard to the other professions, nor does it now occupy the relative position held by it in foreign lands. These are subjects for careful thought and mature reflection and we do not propose to analyze them at this time, but in applying any remedy, some means must be provided for attracting public opinion, through which largely the disease must be reached.

We think the societies have not kept this point clearly in view, their thoughts being too often embalmed in volumes of transactions, which, however useful to individual members of societies, never reach, except to a very limited extent, the non-society engineer, and that great body of educated thinking men of a scientific turn of mind, who are always interested in subjects of an engineering character, and who largely control public opinion. The cordial support of this class is an important factor in the easy solution of the problems.

There is no other method of reaching them except through the columns of scientific papers to which they are the largest subscribers. The societies must see to it that such papers as ENGINEERING NEWS and kindred journals which are throwing their influence into the balance, are most cordially and materially supported, and at no distant day the "balance will kick the beam" at the other end.

TRAUTWINE'S PATENTED TUNNEL.

We notice in the last number of the *Polytechnic Review* (Sept. 2,) a description of an "Improvement in the Construction of Subaqueous Tunnels" recently patented by John C. Trautwine of Philadelphia. The invention itself calls for no particular remark so far as the "*general principle*" is concerned, it having been preceded in that regard, by a design of D. Farrand Henry, Ch. Eng. Detroit Water Works, published at the time of the first tunnel agitation at Detroit. So far as we can judge from the description given in the *Review*, Mr. Trautwine's invention is quite similar in "*general principle*," to Mr. Henry's although there may be such difference in detail as to give it the requisite novelty for a patent.

To preclude any one from taking out a patent mode of sinking tunnels by the pneumatic process, we will state that Gen. Wm. S. Smith has designed a tunnel to be sunk across the Detroit River by this process, and that his proposition to build said tunnel, is now under consideration by the Detroit Common Council. A tunnel of some three miles in length, was also designed several years ago to be sunk in sections across the River Humber, in the north of England. It was, however, never constructed. It will be seen that the idea or general principle is by no means new.

The invention is thus described: "His (Mr. Trautwine's) broad proposition is to abandon the usual method of perforating the tunnel beneath the stream; and to construct it above water, upon a strong solid wooden platform several feet in thickness, which shall serve as a base for it to rest upon after it is finally deposited in its place. The tunnel and its platform are then to be sunk into a trench dredged across the bed of the stream for their reception."

The tunnel may be sunk entirely beneath the bed of the stream or partially as may be required by navigation or the regimen of the stream crossed. Piles may be required for the timber platform to rest upon in soft bottoms.

The tunnel is to be sunk in short sections of a hundred or more feet in length, the joints to be made by divers. In moderate depths the tunnel may be built by cofer-dams, and they might have added—"and in greater depths by means of pneumatic caissons covering the work like a huge diving bell."—Less danger is claimed for this method and less expense in constructing approaches, owing to less depth of tunnel, all of which is no doubt true.

What we object to, is the patenting by an engineer, of a design that a good engineer would be sure to adopt in a proper location, the more particularly when the "*general principles*" are embodied in the previous designs of an engineer for a similar case, and by one whose *esprit* toward the profession as a whole would make a patent for such a plan seem repugnant. We do not know of any law to prevent an engineer, whenever he adopts a new device for a special piece of work, from patenting it, but if such is to become the fashion, engineering will be largely reduced to searching the files of the *Official Gazette*, and paying royalties to patentees. We noticed a couple of weeks since that a Cincinnati man had patented a high and low service system of reservoirs for water works, the one to be used in case of fire and the other for domestic service. Of course the idea is not at all new, reservoirs having been made for similar use long ago. Within a few days we have had another example of a man calling himself a C. E. (?) patenting a submerged crib for the supply connexions of water works.

It is proper enough to patent machines or processes employed essentially in manufactures, where an immense number of duplicates are made to be used by men in industrial pursuits—as agricultural utensils, engines and pumps and machines of all kinds, chemical processes, etc. But we think that every true engineer considers it beneath his dignity to hedge in his brothers by patented designs, especially on works on which it is supposed necessary to employ men of talent to design and execute. Such patented designs will, no doubt, be of great help to that numerous class of empyrics and quacks which swarm beneath the drippings of every corporation.

Compressed Air Street Car.

Engineering of Aug. 18th illustrates a compressed air tramcar which promises to fill a long-felt need. In order that a store of compressed air shall be employed economically heat should be applied before or during expansion. This is accomplished in the present case by causing the compressed air to bubble up through hot water on its way to the engine. The steam mixed with the air gives off heat during the expansion, the steam being condensed, thus serving as a lubricant in the cylinder and packing boxes. The tramcar itself is supplied with thirteen cylindrical reservoirs placed under the floor—nine being 5 feet 3¼ in. in length by 13.78 in. in diameter, and four, 4 feet 3 in. in length by 15¾ in. in diameter, the latter being placed close to the axles. The supply of compressed air is stored at a pressure of 25 atmospheres. The total contents of the reservoir is 70 cu. feet, divided, however, into two series, one of three-fourths the total capacity constituting the working reservoir, the other fourth being held as a reserve, to be used in case of necessity. The separate cylinders are connected by a coiled pipe so that the connection will not be broken by the jar. The distributing pipe passes into the heating vessel, which has a capacity of about 3½ cu. feet and is placed on the front platform. This vessel is charged to about three-fourths of its capacity with water at 320° corresponding to 75 lbs. steam pressure. The air delivered into the heating reservoir at its bottom bubbles up to the surface, becoming charged with vapor. At the top of the cylinder the air passes off through a reducing valve which has an ingenious connection with the main reservoir, so that by regulation, by means of a hand wheel, any desired pressure can be sent to the cylinders. The cylinders are fixed to the outside frames and connected directly to the outside cranks on the leading axles. The distribution of the air is effected by the ordinary side-valve and link motion, and in moving down an incline the engines may be worked in reverse gear, pumping air directly into the auxiliary reservoir.

The total length of the tramcar is 20½ feet, and width 7¼ feet, with capacity for forty-five passengers. It is said to have run lately in Paris 4⅝ miles, with its full load, without being recharged, and the expenditure of air is calculated at 11 cu. feet per mile.

The apparatus is the invention of M. Mekarski. It is to be hoped that something better than our ordinary horse-car will soon be used in this country. We believe that experiments are now making in Philadelphia with steam street cars which are said to be successful. They have been in use for some time in New Orleans and are highly spoken of. We are not informed in regard to the mechanical arrangement of the Philadelphia cars, but, if our memory favors us, at New Orleans the reservoirs are charged with hot water at a high temperature which gives off steam for the cylinders, stationary boilers being placed at intervals along the lines for the purpose of charging the reservoirs. We should judge compressed air to be the most convenient and economical in use, there being but little dead weight to transport which is not true of the water-charged reservoirs, less danger from explosions, and far less disastrous results to follow from an explosion of compressed air, than from an explosion of hot water and steam. The economy of the air in use would, however, be in a measure counterbalanced by the greater economy in generating steam in the stationary boilers and using it directly in the car, rather than through the means of a stationary engine and air compressor converting it into compressed air, to be used in the car, each transformation of power corresponding to a loss. Of course the engines used in compressing the air would be of a more economical type than the steam engine on board the car. The relative economy could only be decided by intricate calculations and then not in a satisfactory manner except by actual results in use. Economy in either case would be subservient to public safety.

ON August 19, telegrams were received by the Jetty company at St. Louis, that there was a clear clannel between the jetties and out over the bar of 20 ft. depth or more and a least width of 140 feet. At this the company feel quite elated, as well they may, but with their assertion that when a least width of 200 ft. is reached, in a 20 ft. channel, the first payment ($500,000) will be due, we cannot agree. It is pretty certain that this 200 ft. channel at present exists, through the jetties into the Gulf, and that by the strict letter of the contract, which was rather loosely drawn, the payment may be due. The spirit of the contract undoubtedly was, at least it was so understood by Congress and the people at large, that when certain depths were obtained from the main channel of the Mississippi River to the Gulf, certain payments should be due, and any quibbling which the company may indulge on that point is certainly in very bad taste and we hope that the reports to that effect will prove untrue. The latest reliable intelligence from the head of South Pass reports a least depth of 17½ ft. for several hundred yards on the shoal at that point. The company are busy constructing works at that point to obtain deep water, and when that is accomplished so that water of requisite depth exists from the main river to the sea, in a channel, prospectively permanent, every one will rejoice and the payment be cheerfully made. The question as to whether a separate bill shall be presented for the works at the head of South Pass, and paid if presented, is one that can well wait on the good feeling engendered by a permanent and deep channel to the sea.

SINCE the above was in type we have learned that on Saturday morning, Sept. 2d, the steamer New Orleans, bearing Capt. Eads and party, was expected at New Orleans via South Pass. The steamer arrived at the jetties on Friday evening and was informed by the pilot Francis that there was not water enough for the steamer to go through the pass. The steamer was drawing thirteen feet six inches forward and sixteen feet six inches aft. The steamer then went around to S. W. Pass, stopping at the head of the passes where Capt. Eads left on the steamer Grafton, for Port Eads. It is also reported that the City of Norfolk of the Morgan line, drawing about ten feet, arrived at the jetties about the same time and went round and came in by S. W. Pass. It would seem as if there must be some mistake in the above statement, especially the latter, or else the reported deepening at the pass is essentially of a sporadic character, not to be relied on longer than the local and temporary causes which produces it. However, statements are so conflicting that it is impossible to reach a conclusion without saying some one is guilty of a prodigious faculty of misrepresentation.

IN our issue of August 12, we spoke of the explosion in the British man of war, "Thunderer", stating that it resulted from neglect to remove the steel wedges by which the safety and stop valves were held in place, after the hydraulic test had been made. This was the report circulated in the London *Times*, and we are glad to say that imputation of such gross carelessness proves, from the investigation that has since taken place, to be entirely unfounded, although the stop valves refused to move from some unexplained cause. It was also brought out that the indicator had once passed the zero and that the pressure recorded, if it was recorded at all, must have been much lower than the actual pressure at the time of the explosion. The safety valves, which were fixed to blow off at 30 lbs. refused to act for the simple reason of too good workmanship or too close fitting, so that by unequal expansion, or rather no adequate allowance being made for expansion, the valves were set tight in their fittings. The valve was of brass and the valve box of cast iron, and calculations on their relative coeffecients of expansion brought out this result which has been repeatedly verified by actual test on a valve of similar construction. Of course the only blame which can be attached to anyone is a lack of consideration of these points in the design and in the construction. Many other interesting points were brought out in the investigation, which however we cannot enter upon. *Engineering*, from which the above conclusions are taken, also reverts to the explosion on board H. M. Ships, "Vesuvius" and "Hydra," and concludes with some severe strictures on "the non-dissemination of information throughout the engineer branch of the naval service," and warns their lordships of the admirality that, "their attempt to prevent the discussion of professional subjects in the public press, must tend inevitably to lower the class, professionally, both as to trustworthiness and zeal."

PROFESSOR GRAHAM BELL has succeeded in transmitting the tones of the human voice by telegraph. The apparatus is similar to the thread telegraph, a toy consisting of two small tin or wooden cylinders, each having a membrane stretched over one end, the two membranes being connected by a stout thread. In the telegraphic instruments the membranes of gold beater's skin are provided with proper vibrating armatures, connected with the wire. Vowel sounds are transmitted with remarkable accuracy. The consonants are somewhat indistinct, but still, it is said, the sentences can be quite readily understood. Musical sounds are accurately reproduced. This invention in connexion with that of Prof. Gray, by which several messages may be sent over the same wire in both directions at the same time, by means of vibrating armatures, tuned, as you might say, to a certain pitch so that each receiver picks out its own message, marks an epoch in modern telegraphic invention.

VOLUME I of the papers read before the Civil Engineer's Club of the Northwest is at hand, and presents a very creditable appearance. Although the society has been in existence seven years, its papers have heretofore been issued in detached form. The present volume is a collection of twenty-one papers read at varioust imes since the organization of the society. The entire No. of papers read before the society during its existence is sixty-two. The membership now numbers eighty-six. Many of the papers have been published in ENGINEERING NEWS and also a list of the members, so we shall not enter on an extended review at this point. The volume will prove valuable to its recipients, and we particularly commend to their careful consideration the matter contained in the last few pages.

PROF. COLBERT, of the *Tribune*, gave an interesting account of the occultation of Saturn which took place on Sunday morning, Sept. 3d, between the hours of 1 and 2. The planet passed behind the moon at a point 28° east of the highest point on her disc. The occultation was visible from all parts of the United States, and continued about 70 minutes.

THE explosion of the Hell Gate rock did not come off Sept. 5th, as announced by the New York *Telegram*, although a most disastrous premature explosion occurred resulting in the death of four men, the probable fatal wounding of eight more, and the injury of several others. The work of charging the blast holes was progressing, a government scow loaded with dynamite, giant-powder and nitro-glycerine being moored at the dock. The explosion resulted from the accidental dropping of a cartridge while the workman was adjusting the top or cap. The workman was hurled a distance of two hundred yards, boats in the river had their windows broken, and houses in the vicinity were severely shaken. The deck of the scow was badly damaged, but, strange to say, the explosion was not communicated to the hold of the vessel which was filled with cartridges. This is the first accident that has occurred at Hell Gate since the commencement of operations. The grand explosion is now announced for the 20th inst.

The Opening of the Inter-State Exposition.

Wednesday night the doors of the Fourth Inter-State Exposition were thrown open to the public, and a flood of light from upward of 7,000 gas jets illuminated the vast building. Not since the inauguration exposition has such a crowd flocked to an opening as that which assembled Wednesday evening.

The general appearance of the building was very gay. The galleries, the roof, and rafters were festooned with flags representative of every nationality. Upon entering by the main door a large space has been left, in the center of which the large fountains throw up cooling streams thirty feet in the air. Last year no space was left here, but the management by an economical arrangement of room have been enabled to keep the center of the building for promenading, and here and there are rustic seats where one can rest and note the passing incidents.

Department A is devoted to a display of agricultural machinery, implements, and tools, and also the latest dairy appliances whereby labor may be economized. The farmer will find this department this year especially inviting. Many new and really extraordinary patents are shown in the shape of reapers, cutting machines, etc.

In the department marked B the general machinery is presented. On the opening evening the arrangements had not been thoroughly completed, therefore a proper examination of this department could not be obtained.

The department labelled C contains all that relates to useful minerals, and then wrought and cast products and the most approved building materials.

The department D comprises the exhibits of textile fabrics, their material and manufacture.

Department E is devoted to that which charms the eye and elevates the taste, household and personal ornaments and goods.

The products of the farm, orchard, nursery, and green house, ferneries and aquaria, are shown in department F.

The department G comprises all that relates to food and drink and tobacco.

Science and education are exhibited in department H, the fine arts in department I, and the liberal arts in department K.

Several of the large dry goods departments are well represented, also the wholesale bootmakers, furniture dealers, musical instrument makers and other large interests.

Civil Engineers' Club of the Northwest.

The Club met at the Sherman House Tuesday evening, the 5th inst. President Chesbrough in the chair, and present Secretary Morehouse, and members Clarke, Greeley, Potts, Willet, Thomes, Williams, Booth, Comstock, Cleveland, Frost, also several visitors, among whom were F. Gottsleben, C. E., and Prof. Ferd. Steiner, C. E., both of Vienna, Austria.

After the approval of the minutes of the last meeting, (the annual meeting in June) a communication from Charles Latimer, Chief Engineer of the Atlantic & Great Western Railway, on the subject of the Divining Rod; and one from T. J. Nichol, Chief Engineer of the Gilman & Springfield Railway, on the subject of Foundations, were read by the Secretary, who also reported that donations had been reciveed, since the last meeting, of statistical tables of the Road Department of the Atlantic & Great Western Railroad, from Charles Latimer, and of several public documents from Gen. A. A. Humphreys, Chief of Engineers, U. S. A.

The paper for the evening—"Transportation Routes from the Interior to the Seaboard," by John E. Thomes, C. E., was then read and discussed, after which Mr. H. W. S. Cleveland was appointed a committee of one to correspond with Mr. Latimer on the subject of arranging for a series of experimental tests of the merits of the Divining Rod which Mr. L. was desirous of making. The President called the attention of the members to the desirability of inviting fellow engineers to become members of the club, and referred to the new rule for the nomination and election of members. Reference was also made to the engineering exhibit at Philadelphia and the fact that about $2,000 more was needed to defray the expenses thereof. The President in answer to an inquiry as to the merits of the exhibit, stated that he considered it a very excellent one, and one that reflected great credit on the profession. Messrs. Gottsleben and Steiner, who have been visiting the principal cities of the Union, and inspecting their Public Works, spoke in high terms of the exhibit in Philadelphia, of the valuable information to be gained there, and of the numerous courtesies extended to them by the Secretaries in charge, by which their travels have been much facilitated, time saved, and acquaintance with American Engineering practice greatly assisted. Prof. Steiner considered the exhibit far superior to any which he had seen at the principal European exhibitions which he had attended.

IT is in no boastful spirit that we call attention to the genuinely useful character of ENGINEERING NEWS as a medium of information to engineers, architects, contractors, manufacturers, and that large class of men whose income is derived principally from engineering and building enterprises. From all parts of the continent we are each week gleaning the *news* that is of liveliest interest to them, and our journal is in truth the most faithful index of the works of construction of America that is to be obtained. We have also endeavored in our selections from other journals to consult the tastes of our readers as far as we could interpret them, and our great aim has been to make each subscriber feel a personal interest in our enterprise, and so induce him to use his influence in ensuring its success.

The Wheeler Expedition.

Detachments of the Wheeler expedition have just left Washington for the field of their work. The exploration and surveys west of the 100th meridian will be carried on during the remainder of the year in New Mexico, Colorado, Nevada and California. The sections of country to be explored are contiguous to the finished territory surveyed by this body, or by Clarence King in previous years, and the triangulation will be an extension of the systems, already completed, to which it will be joined. There will be two points of rendezvous and outfit—Carson City, Nevada, and West Anamas, Colorado. At these places the executive and scientific attaches of the survey, some fifty in number, are now gathered, and here the expedition will receive numerous additions to the outfit in the persons of guides, packers, military escorts, etc. Seven working parties will take

the field, it having been found that the work can be most vigorously carried on by a small corps of eight or ten persons. Each one of the Eastern parties will traverse the country on both sides of the Rio Grande, south of the latitude of Albuquerue, New Mexico. The other to be engaged in Colorado, will proceed to the northwestern corner of that State, and in the course of the season acquire the data necessary for the completion of the maps of the territory. Five parties will operate on the Pacific coast, taking Carson City as their initial point. From there they will make a survey eastward over the plains and isolated mountain region of Nevada and westward into the rugged Sierra Nevada range, along which the triangulation will be developed above the Central Pacific railroad, working in the vicinity of Beckwith Pass, and as far towards the northern boundary of California as the shortness of the season will allow. As yet the topography of these regions is but slightly known, and as the tide of settlement is turning in these directions, it has been deemed advisable to immediately cover them with a systematic geographical survey, which will also take cognizance of and report upon the natural resources of tne region visited.

Publications Received.

From the Institution of Civil Engineers.

Hydraulic Canal Lift at Anderton, on the River Weaver. By Sidengham Duer, B.Sc., Assoc. Inst. C. E.

*Sewage Utilisation: comprising the following:—*I Sewage Interception Systems, or Dry-Sewage Processes, by Gilbert Richard Redgrave, Assoc. Inst. C. E. II. The Treatment of Sewage by Precipitation, by William Shelford, M. Inst. C. E. III. Report of the Discussion upon the Foregoing Papers.

*Rainfall and Evaporation: Comprising the follow*ing:—I. On the Floods in England and Wales during 1875, and on Water Economy. By George James Symons. II. On Evaporation and on Percolation. By Charles Greaves, M. Inst. C. E. III. Report of the Discussion upon the Foregoing Papers. IV. On the Percolation of the Rainfall on Absorbent Soils. By John Evans, F. R. S., Assoc. Inst. C. E. London, 1876.

The Dhu Heartach Lighthouse. By David Alan Stevenson, B. Sc. Edin.

On the Changes in the Tidal Portion of the River Mersey, and its Estuary. By James Nelson Shoolbred, B. A., Assoc. Inst. C. E.

A Report of S. T. Abert, U. S. Civil Engineer, on the Survey of a Line to connect the waters of the Cape Fear and Neuse Rivers, and for a connection by water between Norfolk and Cape Fear River, with maps. Washington, 1876.

The Nursery for September.

*The Journal of the American Society of Civil Engi*neers for June, 1876.

Vol. I. Transactions and Proceedings of the Civil Engineers Club of the Northwest, containing the Constitutions of the Club, the List of Members of the Society, Proceedings of Annual Meetings, and copies of Papers read before the Club since 1873.

NOTES.

West Fitchburg's (Mass.) water works are to be enlarged to about 1,200,000 gallons daily capacity.

The American Association for the Advancement of Science closed a most interesting session at Buffalo on Wednesday of last week.

The falls of Montmorency, province of Quebec, were nearly dry Aug. 22, a spectacle never before seen by the oldest inhabitant.

Owing to the recent dry weather, the Connecticut river, at Bellow's Falls, is so low at one place, the water measures only ten feet in width.

The city of Worcester, Mass., has been sued for $200,500 damages by the persons whose property was injured by the breaking of the reservoir dam last spring.

Mr. Edward Andre, Landscape Architect of Public Works of Paris, is making a tour of this country. He has arrived from South America, where he was sent on a scientific mission by the French government.

The continued dry weather has so dwindled the streams that feed the Croton river that a large quantity of water has to be drawn from the lakes and storage reservoirs in Putnam county, and the Commissioner of Public Works of New York requests the people to carefully abstain from wasting the Croton water.

A Halifax merchant is making arrangements to secure a cargo of grain in the west, convey it over the Intercolonial railway, and ship it at that port for Europe, and thus ascertain the chances of making Halifax a profitable grain-shipping port.

The connection between the lake tunnel from the crib to the shore and the large new tunnel from the shore to the pumping works has been made. This will complete Cleveland's new water works, tunnel a mile and a half under the lake, shore tunnel to the pumping house, new buildings, new boilers and new engines, with the old ones in reserve—thus giving Cleveland a series of the best water works in the country.

We learn from the Albany *Argus* that the material for the new iron structure crossing the west branch of the Hudson, has nearly all arrived. One span of the bridge will be put into position this week. The work of dismantling the timbers of the second span is nearly done, and has proved very tedious, as the wooden timbers are pinned with wood, and the whole bridge was erected in a time when they believed that the best was the cheapest.

The work on the new water main of New York, which is to complete the down town water system, was commenced Aug. 29, at the corner of William and Chamber streets. About fifty workmen are employed on that branch of the line, and an equal number will begin soon at the end of the proposed line in Wall street, and work up town to connect about Fulton street. A large cargo of pipes was received on the 28th inst, and every effort will be made by the contractors to finish the work within six weeks.

At Albany, N. Y., work has been commenced on the new pumping house to be used in connexion with the Prospect Hill reservoir now well on towards completion. The pumping house is 36x41 ft., and 32 ft. high, built of pressed brick with cut stone trimmings. The boiler house is built of the same material and will be 40x35 ft., and 22 ft. high, provided with an ornamental chimney 100 ft. high. The building will be ready for the reception of the machinery before the reservoir is completed.

The Green Bay *Gazette* says: The extreme high water this season has caused considerable portions of the grassy formations near the mouth of the river to break from the mainland and float off. A piece was lodged near the East river Main street bridge, the other day, nearly closing the river, and a large piece passed up Fox river one day last week. Duck creek, below the bridge, is completely closed to navigation by one of these floating islands, and the men engaged in boating lumber, stone, and brick from that stream, have been obliged to remain idle for a week.

The city of Montreal is building, by day labor, a low level main sewer 8 feet inside diameter, "wagon shape," which is to be 8,650 feet long; the estimated cost is $200,000, which however did not provide for quicksands, and so far they have been troublesome; they occur at a depth of 35 feet below surface level. Some 1,500 running feet of the sewer is constructed; it is of 12-inch brick work, and is said to be one of the finest pieces of workmanship of the kind in America. White English Portland cement is used throughout, the present low rates of freight from Liverpool having brought the price of that article 25 per cent. lower than last year, the city takes advantage of it.

The work upon the Newton (Mass.) water works will probably be completed in six or eight weeks. The building for the pumps and boilers is 100 x 52 feet, and the coal shed 45 x 45 feet. The chimney is 100 feet high, 8 feet square at the base and 5½ feet at the top. The filtering basin is located on the Needham side of the Charles river and is 60 feet wide on top, 10 or 12 feet on the bottom and 800 feet long, with provisions for lengthening it when necessary. A 24-inch pipe laid 5 ft. under the bed of the river will connect the filtering reservoir with the pumping well. Newton has long suffered from defective drainage and at an early day a commission of two citizens and an engineer will be appointed to make investigations and decide upon a plan to remedy the evil.

The main branch channel of the Patapsco river at Baltimore, Md., is 24 feet deep and 150 feet wide from Winan's wharf to the main ship channel, and will be completed in about a week. The whole dredging will comprise 150,000 cubic yards, 130,000 cubic yards of which have already been removed. When the buoys, about eight or ten in number, are placed in position, the new ship passage will be open for navigation. Opposite Fancher's upper wharf the channel has been made 350 feet wide, so as to permit the largest vessels to turn about. The Morris & Cummings Dredging Company, the contractors, commenced dredging this channel about three months ago, and, with the advantage of improved machinery, have been enabled to progress so rapidly with the work. When the work is completed the three machines of the company will be employed in the basin, whence they have contracted to remove 350,000 cubic yards. A large portion of the work has already been done in the basin.

The coast survey on the Pacific comprises about fifteen parties, whose labor extends over the whole surface of the country, from the straits of Fuca to Mexico, and eastward to the neighborhood of Salt Lake, all under the direction of Prof. Davidson. Over 200 men are employed, besides seven steam and sail vessels and several pack trains. On the northern coast there will be this season a primary triangulation of the straits of Fuca by Captain J. S Lawson, with the brig *R. H. Fauntleroy*; hydrography in Puget Sound by Assistant Gershon Bradford, with the schooner *Yukon* and steam launch; topography in Puget Sound, South Duwamish Bay, by sub-Assistant E. Ellicut with camp outfit and steam cutter, and topography and hydrography of the Lower Columbia river, by Assistant J. J. Gilbert with barge *Kinchelow*. The appropriation of the government is only $200,000 this year. The work will take years to finish if carried out as proposed by Prof. Davidson.

The Baltimore *Sun* of Sept. 1st, says:—It is stated by parties interested that to-day the work of laying a pipe line will be commenced, for the transportation of crade petroleum from the oil fields of Western Pennsylvania to Baltimore, a distance of 225 miles, with Brady's Bend as the Pennsylvania terminus. This pipe-laying scheme, which has been fully explained in the *Sun*, has the support of parties in Baltimore, who secured a charter from the Maryland Legislature last winter, which charter was incorporated with the Pennsylvania organization. The project has many and powerful opponents in Pennsylvania, including the railroads, Pittsburg refiners, etc., who do not want the refining business transferred to the Atlantic seaboard, which would result if Pipe lines were laid to bring crude oil to the seaboard cities, as contemplated. The prosecution of the work will probably be the signal for the opening of legal hostilities, and it is stated the pipe line company has strong backing to wage the contest. With no legal obstacles it is claimed the line could be completed in ninety days.

The Lake Montebello Drainage Tunnel, Baltimore, was run through on Friday of last week, the connections of the three sections having been successfully made. The complete success of the tunneling was the cause of much rejoicing by those interested, and in celebration of the event Mr. John E. Eschbach, the contractor, entertained the employees on the work, Robert K. Martin, engineer to the water department, Charles A. Cook, resident engineer, the assistant, Mr. Kenly, and Samuel W. Knapman, superintendent. The three sections are respectively 1,140 feet, 900 feet, and 814 feet, and are 13½ feet in diameter. When the brick-work is completed the tunnel will have a uniform diameter of nine feet. The work was commenced in January last and will be entirely completed in a few months. A large part of the tunneling was through solid rock, the drilling being done by an engine worked by compressed air. Last week Mr. Eschbach commenced work on that section of the main conduit of the Gunpowder water supply which runs from Lake Montebello to Homestead, where it will connect with a conduit to the city. A shaft has been sunk at Lake Montebello, and work has also been commenced at the open cut on the John Hopkins property.

The Illinois Water Route from Chicago to the Mississippi.

BY F. M. HARRIS, C. E.

[Written for Engineering News.]

In view of its power to regulate commerce between the several states, Congress, in 1873, appointed a commission to investigate the subject of transportation, which submitted a most exhaustive report, from which many reliable facts can be obtained on the subject in question.

In comparing water and rail routes from various inland points to the seaboard, they show a difference of 24 per cent. in favor of water transportation. In the winter months rail rates are shown to to be 44 per cent. higher than when water competition is in full force, and charges west of Lake Michigan were found to be double those east, except where influenced by canals. The commission recommended to Congress, as a solution of the "Cheap Transportation Question," three water routes from the Mississippi valley to the seaboard—a northern, a southern and a central. The southern is completed by joining the great bend of the Tennesee with the head waters of the Altamaha river, reaching the seaboard a short distance below Savannah.

The central connects the Ohio with the James river by means of the Kanawha river and a short canal. The northern needs but the connecting of the great lakes with the Mississippi river. There are two natural routes between Lake Michigan and the Mississippi river, one through Wisconsin and one through Illinois. Each requires slack water in connection with a short canal. Both routes have been under progress of construction for a number of years.

The Illinois route consists of the Illinois river and a canal ninety-six miles in length, connecting Chicago harbor with the river at La Salle. The canal was completed in 1848 under the management of a Board of Trustees, who took possession June 26, 1845 and gave a release deed to the State September 11, 1871. The general account of the board exhibiting all moneys received and expended between these dates, shows their receipts to have been $11,008,508, and their expenses to have been $10,913,765. The canal is of the ordinary capacity, has sixteen locks, with a total fall of 145 feet. The average annual tonnage for the last sixteen years is 663,290, the greater part consisting of lumber and grain. This latter is carried for 2½ mills per 1,000 lbs. per mile, and the former for 6½ mills per 1,000 feet per mile.

The net proceeds to the State range from nine to twelve thousand dollars per annum. The usefulness of the canal being much impeded by low water in the Illinois river, the matter was brought before the Legislature, and "An Act for Canal and River Improvement" was approved Feb. 28, 1856. Three Commissioners were appointed and an appropriation of four hundred thousand dollars was made Feb. 28, 1869, to be expended in building a lock and dam, and in dredging the river at the mouth of the canal. The act of 1867 contemplated a lock 350′ between gates and 75′ in width, to be constructed of stone. On this basis the engineer in charge, D. C. Jenne, submitted the following estimate of the cost of a lock and dam to be located at Henry, 28 miles below La Salle.

For construction of lock complete.....	$292,100
" " dam "	70,625
Engineering and contingencies.....	36,272
Total	$398,997

The contract was let to the lowest bidder, E. J. Sherborn & Co., of Chicago, for $361,720, who with consent of the commission transferred it to Millard Johnson, of Fulton, N. Y., Dec. 14, 1869, to be completed Sep. 1, 1871. Owing to delays from high water, the work was not completed until Jan. 11, 1872, adding considerably to the cost of the work, which fell, however, within the appropriation. The improvement is of the most substantial kind and gives seven feet of water at all points between La Salle and Henry. Lock No. 2, located near Copperas creek, fifty miles below Henry, is now building. The plans adopted are those of the State Engineer, Mr. Jenne, and are very similar to those adopted at Henry.

The general government in 1873 appropriated $100,000 for the improvement of the Illinois river, $62,358.60 of which, exclusive of engineering expenses, was expended in putting in the foundation of the lock at Copperas creek. April 17, of the same year, the State appropriated the proceeds from the canal and the lock at Henry to the furtherance of the work. Twenty-two bids were received by the commissioners for the work, exclusive of foundation, ranging from $495,095 to $267,219. The contract was awarded to the lowest bidder, Willard Johnson, of Fulton, N. Y., who had previously contracted with the U. S. Engineers for the foundation.

To begin the foundation of the Lock, a pit 500x110 ft. was dug on the right bank of the river to a depth of 12′ below low water, requiring the removal of 41,000 cubic yards of earth. Three thousand bearing piles one foot in diameter were driven in seventeen rows three feet apart in the row, and the rows three feet apart under lock walls and ten feet apart under lock prism; timbers 12′x12′ were placed on eleven of these rows, the seven in the prism and the two under each wall, running the entire length of the foundation and bolted to the piles; on top of these transverse timbers were placed six inches apart, extending the whole width of the foundation; under the lower miter sill the transverse timbers were placed close together; the timbers were bolted at every crossing and the spaces filled with concrete, from three inches below the bottom of the lower timbers, to the top of the upper, a depth of 27″; the whole was then covered with two layers of planking, the first 2½″ the second 2″ thick; transverse binding timbers 6″x8″ are placed over the lock prism at intervals of 10′, and bolted down with ragged bolts 20″ in length, and on this foundation the walls of the lock are built. They consist of two parallel walls 476′ long, 72′ apart at the base, connected at the upper end by two cross walls; the first or breast wall is 6½′ thick, the miter sill wall consists of one curve 18″ thick laid to a curve of 80.83′ radius on the lower side, the upper side forming an angle with the main wall of 68¾°. The main walls are 10½′ thick at the base; have a batter of 1-24 on the face, and a little over ⅙ on the rear, making the wall about five feet thick on top. At the gate quoins the thickness is increased to 18′ at the base and 17′ at the top. For a distance of 100′ at the upper end, the walls are carried to a hight of 26′, and for the remaining distance, 21′. The walls are strengthened by buttresses 3′ thick at intervals of 15½′, extending below the lower gates 20′, and above the breast wall 15′. Joliet limestone is used; the face stone are cut to ¼″ bed in joints, and the backing to 1″ bed and 2″ joints; all laid in the best hydraulic cement, with vertical joints grouted. From the head of the lock heavy rubble walls will extend, forming an entrance, that on the right will turn with a shoulder toward the shore joining a slope wall protection to a guard bank; the other, on the river side, will extend 100′ up stream, flaring out from the line of the main wall 15′, then forming a pier head of 8′ radius and running back parallel with the main wall, to a similar pier head at the foot of the lock. This enclosed area forms the right abutment of the dam. All vertical walls are built on timber grillage.

The gates will be 21′x43′, built of white oak timbers ranging from 6″x12″ to 12″x12″; will have a thickness of 28″ at the heel and with the segmental timbers will be 42″ at the center. The whole is faced with 2″x10″ plank, placed vertically. The gates are securely trussed, and supported by four rods running to the top of a cast iron pillar 8′ high securely anchored on the coping of the wall. The valves for filling and discharging the lock will be placed at the bottom of the gates; are to be 32 in number, 30 of which will be 2.5′x4′. They are to be worked from the top of the gates and will fill or discharge the lock in 3½ minutes.

The gates, like those at Henry will be operated by capstans and spars, and can be opened by two men in four minutes. Time of lockage at Henry, including collecting of tolls, rarely exceeds 30 minutes, or about one-third the time usually consumed at similar improvements.

Both locks have a length of 350′, width of 75′, give 7′ of water over the mitre sill and will pass twelve ordinary canal boats at one lockage.

The dam will be similar to the one at Henry, which is made of timber cribbing and filled with stone; will be about 650′ long, 12′ high, with a base of 45′, an apron of 25′ and a drop of 6′. The apron is to be on a level with low water; the cribbing will be sheeted on either side with piling and filled in above and below with rubble.

The present contractor, Mr. Archibald McArthur of Chicago, who assumed the contract from Willard Johnson, July 1, 1875, was to complete the work by Jan. 1876. Owing to continued high water, little has been done this season, excepting delivery of material. It is expected that the work will be completed by the close of the season, excepting the dam. The water this season has reached 16.2′ above low water mark and stood 8.5′ on Aug. 5th. The cost of the entire work is estimated at $400,722. There remains about $100,000 worth of work to be done. The river from LaSalle to the mouth, a distance of 230 miles, has a fall according to the government surveys of 1866 and 1868, of 29.5′. Three more dams will make the river navigable for all boats traversing the Upper Mississippi. Estimates on the cost of the improvement of the entire river have been made and found not to exceed $12,000 per mile, including appropriations made by the General Government.

On Railroad Accounts and Returns.

A paper read before the American Society of Civil Engineers by William P. Shinn, Member of the Society. Presented June 2nd, 1876.

In the report of the Railroad Commissioners of Massachusetts for 1875 as well as in previous reports, special and needed mention is made of the great defects in the keeping of accounts by railroad companies, and of the total want of reliability of returns based on accounts so miscellaneously kept

Having had a large experience in railroad accounts, and from a personal investigation of the affairs of many railroad companies, having learned that lack of any system of accounts worthy of the name is the rule, and its existence the exception (particularly on the old and long established roads), I beg to offer the following suggestions.

As to *Accounts*—they being the basis from which returns are to be made, and the returns being worthless unless accounts are correctly kept, it would seem to logically follow, that if the State is authorized to require *returns*, and does require them, it should also require that certain general principles should be observed in keeping the *accounts* from which returns are to be made, and on the correctness of which returns depend.

I suggest as proper requirements in keeping of *accounts* that—

1°. *Earnings* should be shown and reported rather than *receipts*, as a large proportion of each month's "earnings" only become "receipts" in the following months.

2°. *Expenses* should include all liabilities incurred for services *rendered* and materials *used* in the current month, and other liabilities liquidated in amount, regardless of when they are paid or payable.

3°. *Maintenance* should include the cost of labor and materials expended, such as may be necessary to make and keep the track, machinery and structures "as good as new," less the *market value* of the old materials released from use.

4°. *Construction* should include only actual *addition in extent* to tracks and structures, real estate, &c.

5°. *Equipment* should include only actual *additions in number* to engines, coaches, cars, &c., the original number being kept filled by rebuilding, &c.

6°. *Betterments* should consist of the actual difference in value, between *improved* track, structures or equipment and the cost of replacing those worn out, with others of same quality as were originally constructed—such as steel rails in place of iron, brick and stone buildings in lieu of wood, &c.

7°. *Liabilites* should include all expenses incurred and construction, betterment and interest lialilities, which may be *unpaid* at date of report.

8°. *Assets* should include all earnings or income *earned* but not *collected* or become receipts at date of report.

9°. *Interest* should include all interest due or past due, whether paid or unpaid at date of report.

10°. *Cost of operating* should be made up from *expenses* and exclusive of all *betterment* expenditure.

Accounts so kept, and in which the companies were required to report the specific tracks structures, &c., charged to construction and equipment, and the items for which betterments were charged, would be incapable of manipulation in the manner and to the extent set forth in the Massachusetts report, and *returns* based thereon would give a volume of information now sought

for in vain in State reports. The system for keeping them is now in operation on several leading lines in the West, and it is as simple as it is comprehensive.

As to *returns*—the careful investigator into railroad economy will look in vain through all the volumes of State reports to find data upon which to base any calculations as to actual cost of traffic or the economy or otherwise of its transportation, for the following (as well as other) reasons, viz:

Most railroads have a traffic largely preponderating in one direction—much of the traffic transported in that direction must pay (if it is to realize a profit) not only the cost of its transportation, but also that of returning an empty car.

Nothing bearing upon this fact appears in any of the State reports, so far as I am aware, and nothing is more absolutely necessary to a correct understanding of the business of a railroad and of the economy with which its traffic is moved.

I therefore suggest as additional items to be embraced in the returns:

1. Mileage of *loaded* cars in each direction.
2. " " *empty* " " "
3. Ton mileage of freight in " "
4. " " " " passing over whole road in each direction.
5. Earnings from freight in each direction.
6. Earnings from passengers in each direction.
7. Passenger mileage " " "
8. Terminal expense chargable to freight.
9. " " " passengers.

The above are the most important items of information omitted, although there are others which would be desirable, but not so absolutely necessary.

But the requirements and forms of returns do not agree in any two States, and this fact, while it baffles the investigator who seeks to compare the results of operating roads located in different States, also causes railroad companies whose roads extend through or into several States much trouble in rendering their returns, particularly as they are required to be rendered to different dates, thus: Ohio report is to June 30th; Pennsylvania report is to November 1st; Illinois, New York and Massachusetts each to September 30th.

Most railroad companies end their fiscal year at December 31st, but as Legislatures generally meet in December or January, returns cannot be made to December 31st, tabulated, and reports prepared in time to lay before the Legislature, hence the diversity in dates.

As railroad companies require two months at least to close their accounts and make up their returns, and should have three, the most satisfactory date to which returns should be made would be June 30th, giving the companies until October 1st to make them, then the commissioner or other State officer would have two to three months before the Legislature meets, in which to tabulate, review and digest.

That these reforms would meet the views of the accounting officers of the railroad companies, I fully believe, and to accomplish them, co-operation between the various State Commissioners is required.

To bring this about, I would suggest the appointment of a committee of the Society on "uniform Accounts and Returns of railroad companies to State Commissioners," with authority to correspond with the Commissioners of the several States, and to arrange for a meeting with them to consider the steps necessary to the adoption of this desirable improvement.

I have before taken occasion to state to the Society, and I now repeat it as my view, that the railroad companies of the country may be relied on to give to the people of the country the advantage in lower rates of transportation, of all improvements made and economies effected, and it is to investigations scientifically made on data known to be reliable that we are to look for such improvements and economies, hence the importance of establishing the State returns on a correct basis.

The Technical Education of the Mechanical Engineer.

Amongst the requirements of knowledge by the mechanical engineer, under which title is meant he who should undertake the direction of mechanical construction, not the least important is that he should be thoroughly informed in the capability of the handicraft of the workman. The knowledge of the physical properties of bodies, the mathematical propositions of "applied mechanics," the principles and theory of machinery, the construction, form and adaptation of parts in various machines themselves, with the functions they accomplish, can be acquired, to a great degree, by study; but the capabilities of the manipulations of the workshop or work bench will yet remain a mystery, to be unraveled mainly by experience and observation.

In a general sense in the history of mankind, the question of education, or its methods, is not a new one. Each generation, for itself, must be taught and must learn, precisely what was learned by the preceding one; and the race in life of the young man will have commenced just when that of his father did. Possibly, sometimes a small increment of knowledge has been gained, and civilization, in its strict meaning of aggregation of people in cities, has taught some one generation lessons in social demands or developments. Education will have followed, and through a series of generations the children will have commenced at a new standpoint, and a new progress in the arts and sciences has been attained. In the arts, this education of the artisan has generally been traditional—from father to son—from master to apprentice; and when, by turbulence and war, the peace-loving and comfortable citizen has been despoiled of his luxuries and comforts, by those who have not known enough to create them for themselves; the unrecorded knowledge has been, for a time, lost; to be acquired again, "under protection of sword." Frequently, the conquerors have protected and employed the workmen, in more or less enslaved conditions; but with the absence or uncertainty of a free reward, the arts have languished, and have almost, if not entirely, perished—carrying with the loss, the civilization which originally engendered them, and extending the ruin to the victors themselves. A more stable condition of society, where the soldier has not been the ruler, has, in modern times, guarded and fostered the arts and all derived learning; and the last three or four centuries, whose record we have, or are acquiring, has shown a development and growth of the arts and sciences, in unexampled rapidity and magnitude.

The past hundred years alone have witnessed, as seen in the amazing retrospect, the wonderful substitution of machinery for handicraft—of mechanical performance for skilled labor. This has occurred progressively, in the three generations of human life and work which embrace the century, in a kind of geometrical progression for any successive divisions of this period of time.

The apprentice of one hundred years since, acquired by experience the teachings of his master, but applied his labor not wholly to the production of the finished article of trade, but in part to the production of machines which were substituted for his hand tools and hand labor. The grown workman, who was fifteen years later the personator of supposed apprentice, imparted his traditions and acquirements to a new apprentice, who, by the introduction of machinery, was no longer called upon to exercise all the skill, care or thought, that his teacher had been called to employ, because the *machine* had supplemented his tools; another succession and another followed, each time has the machine gained on hand labor, until now the ability of the mechanic consists more in the use of the machine than of the hand. With this progress of mechanism has followed manufacturing, and much of the teaching of the later mechanics has become in the use of special machines, confined to distinct processes, to the nearly complete neglect of handicraft or artisan skill. Manufactories and machines have called into existence a new class of skilled workmen, who shall have learned how to make available, and possess the ability, to bring into novel or repeated practice, the acquisitions in mechanical skill of all kinds; and these men are our mechanical engineers.

The distinguished men in the field of mechanical engineering of to-day, have grown into these positions. The most of their elementary learning has been derived in the workshop, and from the workman, by the traditional method, and their education has been attained in the experience of failure and success which attends new efforts. The more work a man does, the more mistakes he will make; long years of practice have evolved *types* of machines, each detail of which, is an especial result from the labor and intelligence of individual mechanics, and the knowledge of the accomplishment or its methods, yet unrecorded or described, exists only in some directing mind whose capability to apply them constitutes the engineering faculty. The patent records, old and new, cover a small, very small part of the mechanical development of the century, so small that it can almost be said, with truth, that no valuable machine, process or apparatus now is, or ever has been covered by any valid or strictly equitable patent claim—so small that these records are never read either as the total of history, or as a complete exposition of any one appliance in mechanism. Descriptive literature is equally at fault in the completeness and practical application of the knowledge which has been gathered in its pages, so that there remains as the only reliable basis of action by the mechanical engineer, only his *appreciation of the capabilities* of materials, both as materials and in manipulation; the latter being either performed by the workman or by the "*machine tool*."

It is easy to see how this knowledge has been acquired by the present holders of it, but it is obvious that the same path is not open to their successors. The large workshops and manufactories have divided labor, in following out their legitimate end of profitable production, until the mechanic in their employment has become the "operative" or overseer of the operations of a machine, with the least of manual or intelligent effort left to humanity. This operative can scarcely be called a workman, and it is very sure that nothing except the possession of the highest mechanical ability will allow him to become an engineer, even if chance gives him an opportunity to develop the ability, and at all events it is sure that the mechanical engineer of the future who shall rival foreign and other competitors in accomplishments, will have learned in another school. Not only is the *operative* of the special machine thus debarred from attainment of knowledge, but the *workman* in the machine shops, at the smiths' fires, in the pattern room, or the foundry, all in their constancy of labor at their divided branches of industry, are precluded from acquiring general knowledge. Possibly the foreman of a gang of men, or the draughtsman in the office wherein the work is originated, may have the desirable opportunity to witness labor and accomplishment, but the derivation of foremen and of draughtsmen is ceasing to be from the ranks of the operative workman.

Given the educational basis which is now recognized as needful for a civil or mechanical engineer, how is the young man to become a foreman or a draughtsman, in the completion of his course of instruction? Given the ability or executive direction which causes a young man to be selected from out of the group of working operatives to act as foreman; or the mechanical perception which has elevated the youth from the bench to the office desk, how is he to acquire the knowledge of books requisite for him to become a directing engineer? These are the questions to be answered.

There are those who lay great stress upon the value of the old institution of apprenticeship, the return to which is in some way to be supposed to restore the capability of acquirement of engineering knowledge to the present generation, on a footing similar to that possessed by former ones. This view has been advocated very recently to such effect, that a special act of the Pennsylvania legislature was passed at the last session (of 1876), offering extraordinary legal safeguards, and immunities from responsibility, unknown to the old common law, to manufacturers employing apprentices. If these apprentices shall be really taught as of old in the entire art and mystery of their several occupations, in all that the *master* knows, shall be cared for, bodily and mentally and above all morally, during their apprenticeship, so that when they become journeymen, they will (if they have been dilligent youths) be fitted to become masters themselves—not mere laborers—then this law may bear the promise of satisfactory return. But when the obligations of equitable apprenticeship upon the masters, here asserted are admitted, it appears almost certain that the results of this apprentice act, will scarcely fill the expectations of some of its advocates and friends.

In every grade of workshop in England, and especially in the engineers' shops (as the machine shops are there denominated), as well as in the offices of the civil engineers, student apprentices or articled pupils are employed. With regard to the former of these, there are many reasons why a similar practice has not been

and will not be followed in this country. The first of these reasons is the comparative absence in England of that destructive rivalry in mechanical business which exists in America. The rates for labor, and the estimated value of the mineral in that country, have been so low, and the application of machinery so much in advance, (at least until ecent years of the century) that England has led the world for a market. The established product of an English workshop, has at all times possessed what might be called a good will. Few of them will purposely rival, in the same way, another in the production of what is the regular manufacture of the one, and but the exceptional demand upon the other; and purchasers are yet more chary in the acceptance of work from inexperienced makers. A man can be generous who has an abundance; he can be just, where he is sure of just dealing in return. Perhaps the condition of abundance has more relevance to the subject under discussion than that of justice. Not many American manufacturers would accept educated, clear headed, intelligent young men as student apprentices, to learn from their workmen, their machines and their processes, the art and mystery of their business. Beside this the condition of the student apprentices amongst the workman in one of our shops, may be regarded as too anomalous to the habits of the average American workman or foreman, to be supposable in actuality. The second method for obtaining practical experience—that of the articled pupil—suffices in the office of the engineer, but is far from satisfactory as the method to learn the value of the workshop manipulations, to the pupil. In this country, at this time, there are no articled pupils, and even students in engineers' offices are rarely to be found.

Neither a return to the system of apprentices and masters, nor the adoption of the method of pupilage in an office, presents the least prospect of affording the education of the business engineer in the future.

The simple question follows, why should not a boy be taught practical mechanics in the school? and this question carries with it its own reply. There is no reason why constructive mechanism should not go hand in hand with applied (mathematical) mechanics, or why manipulation should not be taught at the same time with the properties of materials in the lessons of the school. In accordance with these views, within the past few years, several of our American colleges have established classes and professorships in conjunction with their courses in technical learning. Amongst these, the Sheffield School at Yale College, New Haven, Conn; the Cornell University at Utica, N. Y.; the Stevens Institute at Hoboken, N. J.; the Free Institute at Worcester, Mass., are prominent examples. Other technical schools have, in different degrees, pursued the handicraft culture of their scholars.

But in thoroughness of teaching, and especially in exhibition of attained success, there is now presented to the admiration of all mechanics, at the Centennial Exhibition, a special example from a foreign land, which should induce emulation. The exhibit made by the Imperial Technical School of St. Petersburg and Moscow, demonstrates the feasibility of so educating pupils, that when they pass out from the doors of their school, they will have become at once scholars in their learning from books, and proficients as educated workmen in the varied branches of the workshop. These young men on leaving college are quite as able to demand work as journeymen, as the average of mechanics when out of their time, for they will have—must have—peformed by unaided effort, such feats in workmanship, within limited times for accomplishment, as none but skilled workmen can do. The demonstration of the Russian schools is, that this practical instruction can be given in the fullest range and quality, not only without intefering with, but positively to the advancement of, other indispensable professional studies. From such an example there should not be the least hesitancy in following the same course in the technical education of the American mechanical engineer.—*Journal of the Franklin Institute for September.*

Railway News.

The Sioux City & Pembina Railway will be completed to Calliope by Sept. 15th.

Steel rails are now laid the entire distance from Pittsburgh to Dennison, on the Panhandle.

The Gilbert elevated Railway Co. have been enjoined not to build its road along Sixth Avenue, New York City.

There are 2,000 miles of narrow gauge Railway projected in Texas, and a portion of each line is under construction.

It is rumored that the Erie & Chicago line will be shortened by running via Mansfield, Ohio, instead of Cleveland as heretofore.

Two narrow gauge engines for the South Pacific coast railroad passed Council Bluffs Aug. 29. Two more are to follow in a few days.

Over 32,000 tons of American steel rails have been received in San Francisco from New York during the past year for the Southern Pacific railroad.

The steamer Ontario is en route for Fort William, on Thunder Bay, Lake Superior, with a second locomotive and six flat cars, for the Canada Pacific Railway.

A road (narrow gauge), to run from Jonesboro to Walnut Ridge on the St. Louis, Iron Mountain & Southern Railway, has been incorporated in Arkansas.

The preliminary steps have been taken to extend the Pacific Division of the B., C. R. & N. Railway from Traer to Grundy Center, in Grundy county, Iowa.

Track-laying is progressing on the Chicago and Lake Huron road in Michigan at the rate of over a mile per day, at which rate the road will reach Vernon Junction before the 25th of this month.

Trains will commence to run on the Southern Pacific Railway from San Francisco to Los Angelos, 490 miles, by Sept. 15th, making the trip in 20 hours. The road will be constructed to Fort Yuma, 250 miles, at no distant day.

Work is steadily progressing on the Western North Carolina Railway from Old Fort (N. C.) to Ashville. The work is largely heavy cutting and tunnelling. 1000 feet of the Swannannoa tunnel is completed leaving 800 feet yet to be finished.

It is reported that the Chicago & Northwestern Railway will enter the field against the Chicago & Rock Island, the Chicago, Burlingon & Quincy and the Chicago and Alton, for Colorado business, proper arrangements having been made with the Union Pacific.

Springfield, Mass., has at last decided a controversy of over thirty years standing in regard to the Bridge street crossing of the New York, New Haven and Hartford Railway. The roadway is to be depressed seven feet and the track raised six feet, making an overgrade crossing.

At Van Buren the Little Rock and Fort Smith Railroad Company is rip-rapping the river front in order to save the depot grounds. They will put in three or four hundred cubic yards of rock, making about fifteen hundred lineal feet. The rock is taken from the cuts in the Ozark mountains.

The first installment of 155 tons of iron for the extension of the branch of the Green Bay and Minnesota road, from Onalaska to La Crosse, was received at Green Bay, Wis., Sept. 5th. The remainder will arrive in a few days. It is expected the track will be laid before the end of the month.

Pittsburgh people are much exercised over what they consider unjust freight discrimination, and are seriously considering the building of a road from that place to some point on Lake Erie, and to connect it with the Baltimore and Ohio, thus giving them a shorter line to Chicago than the present Pittsburgh and Fort Wayne. The new line will be called the Pittsburgh and Lake Erie.

The Iowa Southern and Missouri Northern Railway Company has purchased of the Chicago and Rock Island Company the branch road from Des Moines to Indianola and Winterset. The purpose of the C., I. S. and M. N. is to purchase the Rock Island line from Oskaloosa to Washington, extend the road from Washington to Davenport, from Oskaloosa to Carlisle, and from Indianola to Allerton,

The Dayton and Southeastern (narrow gauge) will probably be pushed to completion by Oct. 1st. The tracks are laid six miles from Xernia and the grading and bridging is finished from that point to Washington Court House. Between Dayton and Xenia a large amount of grading remains to be done but the work is thoroughly under way. The ties are on the ground and the iron is being rapidly shipped for this division.

The Holyoke (Mass.) narrow gauge railroad survey having reached Hartford, the engineers have decided to push it through to New Haven and tidewater. They find it 32 miles from Holyoke to Hartford, and the route very feasible. Then they are going to survey over to Amherst from Holyoke with the idea that the Massachusetts Central will ultimately be built as a narrow gauge road to connect with the Southern Vermont scheme, and so trunk narrow gauge lines from the Connecticut valley ultimately find outlets at Boston and New Haven. But we won't build them all, this year.—*Springfield Republican.*

A dispatch from San Francisco of Sept. 5th, says: The last rail of that portion of the Southern Pacific Railroad connecting this city with Los Angelos was laid this afternoon at Langs station, 42 miles from Los Angelos, in the presence of a large concourse of spectators, including a party of prominent railroad men, city officials, capitalists, journalists, etc., from this city. A force of 5,000 laborers was present, who laid the last thousand feet of the track in five minutes. Chas. Crocker, president of the Southern Pacific, completed the work by driving a golden spike with a silver hammer presented by the city of Los Angelos. At the conclusion of the ceremonies the party continued its journey to Los Angelos, where they will be entertained as guests of the city this evening. The road is now completed to within 100 miles of the Colorado river, which will probably be reached before the close of the year.

Articles of incorporation have been signed for a Company to build a standard-gauge railroad from Waterloo Valley, Nebraska, or some other feasible point near Omaha on the Union Pacific, through the counties of Saunders, Butler, Polk, etc., to be extended in the direction of the Republican Valley. The county-seats, Wauhoo, David City and Osceola, will be stations on the line. The parties interested in the proposed Company are all interested in the Union Pacific Company, and the principal owners of that road, Oliver Ames, Sidney Dillon, Jay Gould and others, have pledged the money to construct the road. They have authorixed Mr. S. H. H. Clark to guarantee the construction of the new road to Wauhoo, twenty miles, by the 1st of January next, and similar guarantees will probably be made providing for its construction, at the earliest date possible, through Butler and Polk counties. The Company proposes to ask a moderate amount of bonds in aid of the enterprise from the counties traversed.

Foreign Intelligence.

A company is organizing in France to lay another trans-atlantic cable.

A steam carriage has made its appearance on the streets of Paris and is well spoken of.

The acqueduct from La Vanne to Paris, France, 135 miles long is built almost entirely of *beton corjuet.*

A canal has been projected to unite Berlin, Prussia, to the Bay of the Oder in the Baltic. Its length will be 75 miles, and cost £2,000,000.

The new railroad between Osaka and Kioto, Japan, thirty miles long, was opened during the month of August, and is now in regular operation.

The British Colonies in South Africa now have about 300 miles of railway. A line 150 miles in length was recently opened from Cape Town to Worcester.

Engineers report the result of the soundings in the English channel, for the tunnel from Dover to Calais, very satisfactory. They will be finished by the end of this month.

For the month of June, 18 Cornish pumping engines reported, the average duty of the whole being 51,600,000 foot pounds per cwt. (112 lbs.). One, "West Wheal Seton—Harvey's 85 in.," gave a duty of 67.1 million.

The disagreement between Virginia and Maryland as to their dividing line will probably be settled this month, at a meeting of the arbitrators at Cape May. The space claimed by each is mainly water, and valuable because it contains large beds of oysters.

The German Government has recently built a military kitchen 1,000 ft. long, the machinery of which is driven by two 1,800 H. P. engines. It is capable of reducing to portable limits, 170 oxen, grinding 350 tons of flour, and making 300,000 loaves of bread per day.

Work on the tunnel across the British Channel is to begin on the 1st of July, 1877. The tunneling machinery to be used can bore a drift nine feet in diameter across the channel in two years at a cost of $4,000,000. Four years more and an additional outlay of $20,000,000 will complete the tunnel.

The enlargement of the New York canal locks as proposed in the boatmen's memorial to the Legislature, is the most practical canal improvement that has been advocated for a long time. The proposition is to lengthen the locks so as to admit two boats at once, thus expediting the passage and placing the canal in a condition to introduce barge towing.—*Buffalo Commercial*,

M. Louis Say, writing to the Secretary of the French Geographical Society, announces his intentions to make a new journey of exploration in North Africa with M. Largeau during the coming winter. The chief object is to endeavor to open up the commercial routes between the basin of the Niger and Algeria and to make the ports of the French colony the outlets of these lines.

The London & St. Katharine's Dock Company are at present engaged in an extension of the Victoria Dock, the intended enlargement being upward of 90 acres. The water area will be 7,640 ft. by 540 ft., entered from the river by a lock, 800 ft. by 80 ft., opened and closed by gates operated by hydraulic power. The facing of the dock will be of granite, 30,000 tons of Portland cement will be required. The estimated cost is £1,000,000, and the time of construction 3 years.

On Aug. 11, the English Government advertised for proposals for the "Vanguard" sunk on the Kish Bank by the "Iron Duke," tenders to be received on the 1st of November. The ship is to be sold as she lies, two-thirds of the purchase money to be due in fourteen days and the remainder in six months. The Government engages to buy of the contractor all the guns, projectiles, anchors, and chain cables, and will be prepared to consider favorably other offers for stores, etc; all other property of the ship and the ship itself to belong to the contractor. The Government will also consider propositions to raise the ship itself.

M. Janssen, the famous French astronomer, takes daily photographs of the sun at his observatory at Montmarte, with his celebrated revolver, the same instrument he used in Japan during the late Transit. The solar photographs taken are nearly eight inches in diameter, which, under favorable circumstances he reduces to four inches in diameter. Special interest is being taken now in observations of the solar surface as, according to the advocates of the eleven year period for the maximum and minimum of sun spots, we have nearly reached the minimum period, when there should be very few if any spots visible on the sun's disc.

The Spanish government has appointed a commission to inquire into the physical conditions and possibilities of the Philippine Islands. A professor of botany is to accompany the expedition to report on the nature of the flora of the interior, and on the condition and extent of forests. A careful survey is to be taken of the entire group and a map, drawn up on a large scale, is to be published. The mountain ranges are to be the objects of a special investigation; the hight of all the salient points is to be accurately ascertained, and all traces of metallic products to be noted. The officers in charge of the expedition are to take such notes of observation as shall enable them on their return to draw up an exhaustive monogram on the entire physical condition of the islands. It is to be expected that many branches of scientific inquiry will profit by this research in a so long neglected and most interesting region.

The reduction of the English observations of the transit of Venus is proceeding vigorously under the superintendence of Capt. Tupman. The amount of work involved has been marvelous. About five thousand transits of stars were taken for the correction of clock and instrumental errors. The longitude of the stations at Mauritius and Rodriguez were measured from Suez by Lord Lindsay with fifty chronometers; and Mr. Burton has made more than six thousand microscopic measures to determine the optical distortion of the photo-heliographs. It is self-evident that a considerable time must elapse before the final result, even of the British observations, can be made known; and it is not as yet decided whether a separate value shall be deduced from these, or whether they are to be combined with the results of all other nations.

Contractors' Intelligence.

Since 1840, £25,548,703 has been spent on the churches of England and Wales.

Six thousand unoccupied houses in Glasgow, Scotland. Cause, speculation building. Is there a Chicago in Europe?

Work is soon to commence at Jonesboro, Craighead county, Ark., on the Memphis & St. Louis narrow gauge railroad.

Several contractors left Little Rock, Ark., Aug. 31st, for their work in the Memphis and Little Rock railroad bottoms.

Winona, Minn., has now over three miles of watermains laid, the contract for laying the last 8,000 feet having been completed on Aug. 29.

The Institute of Technology at Boston is about to establish a course in practical mechanics on the Russian system of actual shop instruction.

The sleeping car companies are finding it very difficult to furnish coaches to supply the demand, more especially over the lines traveled in reaching the centennial.

A large iron bridge has been completed across the White river on the Wisconsin Central Railway. It is 1,525 feet long, 107 feet to the top of the rails, and cost $200,000.

The Chicago Common Council is now wrestling with the gas question. As the cost of the city lamps is something over half a million per year, the subject is one of some importance.

The railway bridge over the Kishwaukee river at Belvidere, Ill., on the Beloit division of the Northwestern road, has become unsafe, and the company is now engaged in putting in a new one.

Probably the largest belt ever built is one just completed by Wm. Sellers & Co. of Philadelphia. It is a double leather belt, 200 ft. long and 60 in. wide, requiring 200 hides and weighing over a ton.

The spire of the new Fifth Avenue Presbyterian church (Rev. Dr. Hall's), New York, was finished a few days ago, the capstone having been put on at a hight of 286 feet—two more than Trinity.

The proposed Cincinnati and Portsmouth Narrow-gauge Railway will be 40 miles in length, and will run through a fine country via Mt. Washington, Raven's Corners, Forrestville, Amelia, Bethel and Georgetown.

The Board of Public Works of Chicago on Saturday filed the bonds of Mackin & Wilson, contractors, who propose to pave North Dearborn street, from Illinois to to Indiana streets, to be paid for by private subscription.

Cox Bros., contractors, received on Saturday, from the Board of Public Works of Chicago a final estimate for work on the land extension of the new lake tunnel. The work already done in this matter has cost $478,735.

The new Territory Pembina, of which there is talk of erecting out of a portion of Dakota, covers 72,930 sq. miles. There are within its limits 5,000 miles of navigable waters, including the Missouri Yellowstone and Red rivers.

The Washington Monument Society has voted to transfer the monument to the government. $230,000 has been expended upon it and as the $200,000 appropriated will hardly finish it, subscription books will be opened.

Fitzsimmons & Connell, contractors, received an estimate from the Board of Public Works of Chicago on Saturday for work on the Fullerton avenue conduit. The total estimates so far on that work amount to $165,671.

The King Iron Bridge Co., have recently contracted for the following bridges: For 600 feet of truss bridge for Lewiston, Pa., two arch bridges, one of 520 feet and the other of 300 feet for Iowa, and a smaller one ordered for the city of Philadelphia.

The contract to furnish material for and to construct the abutments and retaining walls of a bridge over the Potomac tunnel, at Baltimore, Md., at Argyle avenue, formerly Walsh street, has been awarded to T. J. Osborne at $7.40 per cubic yard for masonry.

The work of constructing a bridge across the Hudson river at Poughkeepsie, New York, will commence next week. Nearly $200,000 worth of lumber have been contracted for to build the first caisson, and stone has been purchased for the first pier.

The Pennsylvania Transportation Company has given out orders for the 286 miles of 4-inch pipe required for its oil line to the seaboard. Over 8,000 tons will be required, costing over $750,000. The pipe is to stand a test of 1,500 lbs. to the square inch. The whole is to be completed by the first of Dec. next.

A bridge 440 feet long, costing $47,500, has been completed at Ottawa, Canada, by the Wrought Iron Bridge Co., of Canton, Ohio. The bridge consists of one truss span of 100 feet, two deck-arch spans of 74 feet each, and one truss span of 90 feet, with two short spans for the approaches. The width is 53½ feet.

The new State House at Springfield, Ill., is nearly complete, about 100 feet of the dome and some of the inside finishing remaining to be completed. The building is 400 x 378 feet, and the dome is to be 312 feet high. The estimated cost is $3,500,000, but it will probably require an additional million to complete it.

The Board of City Works of Brooklyn, N. Y., at their meeting Aug. 29, received from the Chief Engineer the papers, maps, etc, in connexion with the proposed grading and paving of Park Avenue, from Halsey street to Kent avenue, and from Spencer street to Nostrand avenue. The estimated cost of the work is $14,-933.74.

The old wooden bridge over Dale Creek gorge, on the Union Pacific Railroad, has recently been replaced by an iron trestle under the direction of Wm. Cliburne, Ast. Eng. Union Pacific. The gorge is 125 ft. deep, and 500 ft. wide, and the iron truss bridge is of 13 spans, 40 ft. in length, supported on iron columns 111 ft high. The iron work has been erected in less than 7 weeks and without the detention of a single train. The wooden trestle was by no means in a dangerous condition, the risk from fire being the cause of removal. We believe the iron work was constructed by the American Bridge Co. of this city.

The American Bridge Company of Chicago, which has taken the contract for the construction of the bridge across the Hudson river at Poughkeepsie, has directed the chief engineer of the Poughkeepsie Bridge company to determine the position of the piers in the river, so that a thorough examination of the river bottom may be made, preparatory to beginning the work. The whole cost of the bridge and its approaches is estimated at $5,000,000. According to the terms of the contract, the construction company agrees to build the bridge, and to accept as payment $1,000,000 in cash, and the remainder in the securities of the bridge company.

The first of September finds Contractor Wood just about ready to begin dredging the Cove at Providence, R. I. The dredger will be at work probably as early as Wednesday of next week. The preparations have necessarily been quite extensive. A strip of the Cove Promenade has been graded down to the water's edge; cars and machinery brought here, and there has been built for the work, within less than two months, half a mile of railroad, four large scows, a small tank locomotive, a dam, two swinging bridges and a dredging machine. The cars are like common dumps, except in being much lower. The water in the Cove is not deep enough to allow the men to dredge wherever they like at first, but the dredge will have to dig its own way out into the basin.

Water Works, Ancient and Modern.*

BY E. H. D'AVIGDOR.

The subject on which I propose addressing you is very wide, nor would I undertake it if I had not for several years past devoted much attention to it, both in theory and practice. In principle I fully agree with the opinion lately expressed by this Institution against any *specialising* of our profession. I am persuaded that a splitting up of our practice into a number of separate branches, such as railway, bridge, road, traffic, and hydraulic engineering, would only lead to narrowness of views and onesidedness which is inconsistent with the progress of general culture and enlightenment. In Eng-

* A course of papers delivered at the Austrian Institution of Engineers and Architects, December, 1875, and January, 1876.

land practice as such has attained a level which is almost, if not entirely, unequalled in any other country; yet we find the same civil engineer taking up and carrying out the most varied works. In France *theory* is as perfect as practice in England. Yet there the *ingenieur des ponts et chaussees* is called upon to design, execute, and report on every species of work from a railway to a breakwater, from a culvert to a drain. But of course circumstances arise which give one man more insight and practice in a special branch of our extensive profession than in the other numerous ones; and, therefore, although I began by declining to admit that there should be special water works engineers who do nothing else, yet I may have been able in the course of my studies and experience to collect a few facts which may be new to some members, forgotten by others, and not uninteresting to those who have made water works and hydraulic construction their special pursuit.

The absolute necessity of pure wholesome water for the preservation of human life was admitted and recognized centuries, nay thousands of years ago, although it has occasionally been forgotten for a time. No wonder then that the numerous examples of works for the water supply of towns, and the literature of the subject, make it extremely difficult to condense into the space of a few papers an account of what has taken so many years to achieve. I have found it very difficult to classify all this matter and divide it into groups, so as to give a clear and general view of the whole subject, without at the same time, losing sight of many details of construction which are most interesting to the engineer. You will youself judge whether I have succeeded. In order not to keep you too long, I will only mention that I have arranged my subject in a chronological order, but may, in the course of the lectures, be occasionally obliged to speak of different modes of water supply without respect to time, since it is inevitable that an art like this, in which progress is not constant and continuous, does not supply a regular development of events, such as we find in the history of the electric telegraph or of railways.

Water works were known in the most ancient times, there is an aqueduct supplying the fortress of Cairo, which is said to be 3000 years old. The Greeks possessed many and extensive aqueducts, but we have insufficient data to guide us, and can no longer be certain of the methods they used for supplying their baths and gymnasia with the large quantities of water they must have used, as their literature shows. The historical commencement of water works dates from ancient Rome. Very soon after the Romans had emerged from their early condition of mere colonists, if not marauders, as soon, in fact, as civilization commenced, they were dissatisfied with the water of their river, the Tiber. Three hundred years before our era they began searching for springs to supply good drinking water; we may, in fact, boldly assert that the Romans had thus early arrived at conclusions on the subject of water which were as far advanced as our own a few years ago. Up to 1846 London drew the greater portion of its supplies from the Thames, in places where the water was fearfully polluted by the sewers and drains, in the center of a teeming and industrious, but not over cleanly population; nay, up to this very day, many towns drink the water of the very rivers into which they discharge all their sewers, without disinfecting it, for filtering is of little use against organic matter. But the Romans, a rough nation of peasants and warriors, were perfectly convinced 2200 years ago, that river water is not the best for drinking, and that especially river water polluted by a large town is totally unfit for human consumption. These ancient heroes jumped at once to the very conclusion we have only attained after years of discussion and a prolonged contest with the power of prejudice and indolence, notwithstanding our mastery of chemistry, of medicine, and of the other natural sciences. They at once adopted springs as their sources of supply, and the map which you see before you and on which the different Roman aqueducts are marked, shows that they put their convictions as to the necessity of a large and constant supply of good spring water into practice on the grandest and most extensive scale. (This map will be published shortly with a full page of drawings.)

Many descriptions of these magnificent works have appeared in print; we have neither time, nor is this the place, to examine them in detail. I propose only to call your attention to a few of the principles which guided the Romans in these gigantic undertakings, and if possible to dispel a few prejudices which seem to be still afloat on the subject of Roman construction. No description however would be of any use, if I omitted to explain briefly the foundation on which the whole method of building in ancient Rome and its colonies was based. Without the key much would appear inexplicable, doubtful, nay even quite wrong and impossible. The Roman mode of construction could not have been quite bad, since many aqueducts are the existing witnesses of the strength and perfection of their execution; and Virgo still supplies modern Rome, after having supplied ancient Rome 2000 years ago. On the other hand their manner of construction was very far from perfect, as many antiquaries and enthusiasts would wish us to suppose.

A great author has said, "The Romans possessed more art than science." We must remember that science was then quite in its infancy; higher mathematics were completely unknown; the laws of nature were obscured rather than explained by an absurd if beautiful mythology; the simplest calculations were impossible; in fact, there was no such thing as *theory* at all. It is no wonder then that the Romans worked by rule of thumb only; but, then how they carried out their rule of thumb! We have certainly managed to make some progress since their time by dint of our formulæ and our scientific theories, but the step in advance which we have made sinks into nothingness when compared with the step they made in comparison to the times which immediately preceded them. I think we may still learn something from the rule of thumb of the Romans; but if we are all too clever to learn I am quite sure that at any rate it must be interesting to inquire what they did without formulæ and engineers' pocket-books, and how they did it.

The numerous drawings and photographs of the Roman aqueducts which exist everywhere, will show those who have not seen the remains, what they are now; we can easily judge what they must have been then. But in order to judge these works correctly, we must consider under what circumstances they arose. There was no special municipality or town government in Rome; Rome was town (urbs), the government of Rome was also that of the civilised world. The Roman aqueducts were therefore all constructed either directly by the government or by politicians who wished to obtain the favor of the populace, and built huge water works, which they gave to the public as a lawful piece of bribery. The latter was particularly the case in the provinces. We may almost wish the times back when candidates for Parliament built roads, drains, or water works to bribe their electors; the bribe of unlimited water was better worth having than that of unlimited beer. Among the founders of the Roman aqueducts we find Marcus Agrippa, who was the Thwaites of Augustus' reign; we find the Triumvir Appius Claudius later; the successive emperors sought to obtain the people's favor by the construction of similar works. Even Nero has left some beneficent traces of his government in the aqueduct which bears his name. In the provinces, pro-consuls or governors generally started the water-supply question and carried out the necessary works in the manner we shall presently explain.

The Romans had peculiar means for executing their gigantic works, and these means deserve special consideration, for they explain much in their method of construction. There were in Rome a number of trade guilds, which were perhaps the origin of the well-known mediæval guilds; but the former had, in contradistinction to the latter, fewer privileges, less power, and heavier and more numerous duties. There were guilds of carpenters for scaffolding, carpenters for timbering, carpenters for door and window jambs, joiners, turners, special carpenters for wooden partitions; ordinary masons, masons for large ashlar, masons for small ashlar, masons for arches; stone cutters of different descriptions, each with their special work; stone-hewers, stone-breakers, stone-sawyers, plasterers, wedge makers, etc. In short, each man's work was limited to an almost incredible extent, so that each man obtained the greatest possible perfection in the execution of that work. The mason for arches never did anything all his life but turn arches, the stonemason for small ashlar never had a larger stone to tackle.

The great principle of division of labor, which we are pleased to call a discovery of modern times, was, therefore, already applied by the Romans. Still more remarkable is the enormous power exercised by the State over the above-mentioned guilds. They first arose among the workmen themselves, for the purpose of mutual assistance and support, and the Government, which had at first encouraged them, soon began to fear their increasing power. But instead of attempting to suppress the guilds by force, the State wisely sought to mould them to its own ends. They obtained certain privileges in exchange for the obligation of always supplying the Government with the required number and description of workmen at a fixed rate. They were relieved from a number of different rates and taxes, but in exchange they had to be drilled and incorporated in the legions, and to serve with them in time of war. No actual combatant duties were required of them; they were, however, employed in constructing flying or permanent bridges, fortified camps, and military roads, etc. When the legion settled in a colony, the guilds obtained grants of land and houses, but they were obliged to remain and supply the colony with the skilled labor so urgently necessary for the construction of all civil and military works. By these and other means too long for detail, the Government had constantly at its disposal an army of skilled workmen, and was enabled to execute works in an incredibly short time. Thus the celebrated Baths of Caracalla were commenced and finished within two years, notwithstanding the enormous area they cover, and the great variety of work required in them.

The next point to be noticed is slave labor. Prisoners of war, convicts and vagabonds were obliged to work for their wretched living, serving the skilled workmen of the guilds as laborers. They could be concentrated at any given place in countless numbers, and were, therefore, able, under the skilful guidance of the guilds, to master immense quantities of material, and by multiplication of hands, to move masses which are now transported with but few men, principally by mechanical aid. Besides these slaves, there were families of bondsmen or serfs who obtained certain privileges, and received small allotments of land for their sustenance. They were bound to serve the State when required, and their usual duties consisted in the maintenance of the roads and aqueducts near which they were settled, but they were also often summoned to assist in the construction of new works.

Lastly, we come to the forced contributions or *corvees*, which under the Cæsars had to be supplied by the population through whose territory a new aqueduct or road was carried. These consisted principally, not of manual labor, but of the supply of carts and horses, of stone, sand, bricks, etc. It must not, however be supposed that these, or the other services were performed gratuitously. The guilds, for instance, were extremely well paid. The well-known engineer and antiquarian, Alfred Leger, has given himself the trouble to fix the wages of labor in ancient Rome at the time of Augustus in terms of money of the present day by comparison with the value of wheat, considered as the staple of consumption. He gives us the following figures: The free laborers received about 10d. per day; masons, carpenters and blacksmiths, 3s.; painters, 3s. 9d.; plasterers and decorators, 7s. 6d., besides board, which had to be supplied by the contractor. To supply a further standard of comparison, I may mention that beef cost 7d. per pound, pork 1s., a small fowl, 15d., a pint of wine 8d. You perceive, therefore, that the cost of provisions and of labor was not very different from that of today.

The management of the works was arranged somewhat in the same manner as it is now on the Continent. The chief was the *curator operis*, who had to represent the interests of the State or municipality; the next in rank was the architect, whom we should now call chief engineer. This person was frequently contractor as well (so that even contractor's lines are not entirely a modern invention), but the State supplied the labor and he the materials only. Then came the inspectors or foremen, and lastly, the surveyors or measurers (*mensæ ædificorum*), who also did timekeepers' work. The plans were drawn on parchment by the architects, and when once approved he had no right to alter them except by higher authority.

(*To be continued.*)

THE SOUTH PASS QUESTION.

We give it up! We have endeavored to sum up from time to time the results reached at South Pass. We have in our possession, we believe, all the pamphlets and reports, that have ever been published, pro and con, bearing on the question and a scrap book filled with extracts from New Orleans and other papers, purporting to give the progress of the work and the results obtained; but with all this information and the mental gymnastics required to analyse the conflicting theories and information, we confess we are reduced to a hopeless state of ignorance in regard to what has been accomplished. It would seem as if the profession so far as this work and those interested are concerned, had lost its *esprit* and was reduced to the level of partisans, making it as impossible to tell the present status and the future prospects of the enterprise, as it is to sift the truth, and prophesy results in a political campaign.

What is the truth? What are the results? We can't tell. The work has already progressed far enough to give positive results. So far as the original theories on which the enterprise was based, they have either, at the present writing, been proved true or false. So far as the works themselves are concerned, it is impossible yet to tell whether they will or will not obtain the requisite depth. So far as the theories are concerned on which the enterprise was based, the question now is, have they been proven or disproven, and are the auxiliary works already inaugurated, part and parcel of the original design or subsequently introduced, in order to obtain results which were to be obtained by works based on false premises. or rather on conclusions involving half truths, and which in the heat of controversy were much exaggerated, but are now found insufficient.

So far as we can judge from the reports it is again impossible to decide, and we are thrown back again on *a priori* grounds and in the absence of positive results, necessarily obliged to accept those "facts" which most nearly coincide with and support said *a priori* conclusions. Then what is to be done with the "facts" of an opposite tendency? We can only say with the French savan, when unpleasant facts were hurled against his theory, "so much the worse for the facts." We do not believe that a single engineer who had framed conclusions on *a priori* grounds on either side of this question, previous to the commencement of work at South Pass, when he has looked over the "facts" since reported on both sides, has met anything serious enough to alter his opinion.

The majority of the profession have not by any means expressed any conclusion, if indeed, on the imperfect data presented, they had framed one, preferring, when two great chiefs had championed opposite sides, to wait on dame Nature and see where she would bestow her favors and whom crown with the laurel. Others could see a soul of truth in the conclusions of both parties, but at most, perverted half-truths, and would be more surprised than otherwise if the results should confirm the conclusions of either side in their entirety.

Others still, and a goodly crew, sat, and still sit, astride the fence, and with telescopic vision seeing the result afar off, are prepared to drop quietly on the successful side, and when the victor comes up, shake him vigorously by the hand and whisper in his ear—"I told you so."

Now it is always an admirable thing to be on the safe side. However we do not propose to sit astride the fence and when the result is declared point back to our utterances, calling the world to witness the proof of our prophetic vision. We believe the results will confirm neither side fully, both sides partially. That is eminently safe no doubt, but it must be admitted that the "science of river hydraulics" has not yet reached the stage of a science, most of the conclusions thus far reached being involved in doubt and controversy. This is particularly true in regard to transporting rivers, the laws which govern the transportation of detritus being but little known and mostly in the nature of surmises.

The jetty opponents who have opposed the scheme in season and out of season, "who, having committed themselves to a fossilized idea, strenuously advocate it at all times, who have used their high official position to kill off Capt. Eads' scheme, and failing in that have continuously circulated most false and malicious reports and rumors and impaired public confidence in the scheme, who have, in fact, conducted the controversy in a very unfair and ungentlemanly manner, etc., etc., etc.," have argued against the scheme chiefly on the ground that the accelerated bar advance would cause an unwarrantable annual outlay, and Gen. Humphreys says in one of his reports that it would never be possible to maintain more than twenty feet of water for any length of time.

The jetty advocates, "who scented the 'lucre' afar off, those novices in river hydraulics with crude theories, advocating laws which would reverse the order of nature, men who reviled the labors of their superiors, who were going to give to the country a magnificent strait to the sea, at public expense, minus bottom and shores afar off, those charlatans and quacks, etc., etc., etc.," have argued that no bar would again form except at several miles off the mouth and then not for a hundred or more years.

Such seems to be the spirit in which the jetty opponents and advocates approached each other judging from the language, motions and arguments each attributed to the other. The controversy was almost entirely on the bar which was or was not to re-form under certain conditions. Both gave their theories and the arguments supporting them, incontrovertible to the theorizer, and called up all the river improvements of Europe in evidence. These were quoted in support of either side, with as much facility as the Good Book is made to support conflicting dogmas and tenets. At last Congress gave Capt. Eads the contract.

Now this bar question is not vital. We shall not discuss that at present. It is pretty certain that the bar will re-form and be steadily carried out to sea in the face of the jetties. It will undoubtedly advance somewhat faster than before but not at the rate prophesied by Gen. Humphreys. Suppose it does, with an open river mouth to the sea and the growth of commerce sure to result, two or three hundred thousand dollars more or less spent in keeping the jetties adequately prolonged will not be an expense at which the country will growl.

As we look down the future and see the magnificent commerce sure to result from its success, and the niche in history which Capt. Eads will occupy, we confess we are inclined to throw up our cap and hurrah for the enterprise.

The picture presents itself to our imagination in roseate hues and our wish is inclined to father our thought. It is this wish which has inclined nearly every journal in the land to advocate and encourage it by every possible means. Sincerely as we wish to see it succeed, and much as we shall encourage it in every legitimate manner, it is due the profession that we should reprimand the advocates on both sides for their lack of courtesy, point out wherein the results fail to support the theories advocated and show the grounds on which future results may be predicted and what shall be their nature. We cannot abandon our character as a judge for that of a partisan.

Let us dismiss the bar question for the present as immaterial, for both sides admit that it is a question for treatment after the deep channel is obtained from the main river to the sea. Gen. Humphreys did not give clearly, as we recollect, his reasons for the statement that twenty feet of water never could be maintained to the sea. Possibly it was one of those conclusions which a man eminently familiar with a subject gives through a species of prescience, and for which he can give no adequate reason, but which is entitled to respect if no "incontrovertible" fact is brought up against it.

Since the enterprise started it has had varying fortunes. Suppose you turn a jet of water against a bank of sand. It will excavate a hole; vary its position a little and a new excavation will be made and the old one filled up, but on the whole the jet will tend to excavate a channel. So with the bar. The contracted stream constantly excavates; one day the channel is quite deep and immediately the whole country learns of the wonderful success of the jetty project, and several yards of editorial are written in laudation of Capt. Eads. The next day sees a slight change in the current and the sand is piled up and we hear that a row-boat can't cross the bar. It would seem as if the never ceasing current, on the whole, must make some advance from day to day in removing the bar, and that ultimately the bar *must* be washed out to sea. But here the parallel ceases. Other and more complicated forces are brought into play the result of whose action are not so obvious, and forces that have scarcely been touched, if at all, by the arguments of the principal parties to this controversy. We will refer to these soon.

Since the work commenced the controversy has assumed much the nature of a small boy's quarrel, consisting largely of "you did and you didn't," "it is and it isn't." One boy, thinking himself and his enterprise safe, commenced to abuse the other with vile epithets, whereat the other boy knocked him down with several "malicious falsehoods" and "incontrovertible facts," and held him there until the under boy's friends on whom he depended for his pocket money, ran away, and then he cried out in a loud voice to the "great father" at Washington to pull the big boy off and called on the world to witness how he was abused. The "great father" heard his voice afar off and straightway pulled off the big bad boy, reprimanded him and ordered him to stick his hands in his pockets, and keep his mouth shut, and not to touch the small boy unless the small boy gave him permission. The whole farce was perfectly ridiculous and we confess to a feeling of disgust every time we think of it and can never refer to it in sober terms. Now the little boy has it all his own way and we hope dame Nature will be kind to him, and mollify her laws if necessary in accordance with his wishes. At the present the big boy confines himself to watching the small boy and nudging his friends in the side, and the small boy looks up occasionally to see who is snapping beans at him. We are out of all manner of patience with both boys, big and little, and we take the opportunity to give them a good sound lecture. "Let us have peace!"

THE TAY BRIDGE.

The Tay Bridge on the North British Railway connecting Dundee with that line and furnishing the company with the shortest line between Edinburg and Glasgow and Dundee, and an improved route from England to the east of Scotland, is well on towards completion and the work is so extensive and novel as to deserve description. The bridge was commenced in July, 1871 and was estimated to cost from £200,000 to £220,000. The bridge is shaped like the letter S, and has a total length of 10,321 feet. *Engineering*, from which we gather the facts, says it is the longest bridge over a running stream, in the world.

The Tay is a tidal river, exposed to enormous floods and severe easterly gales of wind, making any construction exceptionally difficult. The bridge as originally planned was to consist of 89 spans of the following lengths: 6 of 28 feet, 28 of 60 feet, 2 of 80 feet, 38 of 120 feet, 1 of 160 feet, and 14 of 200 feet. The middle was to be 88 feet above high water, the grade falling off 21 feet at each end. The number of spans was afterwards reduced to 85 by increasing the length of several of the middle spans to 245 feet.

In the construction of the piers the method adopted was to lay down in the harbor, which was quite dry at low water, two iron frustrums having at the base a diameter of 9½ feet and rising to a height of 8 feet where the diameter was 8½ feet. On top of these cylinders a pier of brickwork was built up to low water level, this brickwork being enclosed in cast iron rings. The pier, weighing some 80 tons, was then floated out between pontoons and lowered on its site by hydraulic apparatus. An air lock was placed on top and through a wall in the brickwork cylinder, 3½ feet in diameter, air was pumped, forcing the water out of the cylinder. Men entered the cylinder, excavating the sand and gravel which was raised by buckets and discharged through chutes into the outer air. When rock was reached the cylinder was filled up with concrete, of five parts gravel and sand to one of cement. On the whole we judge the process to be quite similar to the pneumatic process used so frequently in this country, with many of the American improvements omitted. On the Dundee side of the Tay the bottom was of firm sand, and the sand was washed out of the bottom of the cylinders by hydraulic flow until the blue clay bottom stratum was reached. These methods were of course modified as the individual circumstances of each pier seemed to require.

Latterly the method of sinking the piers has been somewhat changed. An iron cylinder of 31 feet diameter and 20 feet high with an internal brick lining 14 in. thick was built on shore. A temporary cylinder, secured to the lower portion by bolts, carries the caisson 20

feet higher. The whole, weighing some 200 tons, is then floated to its place by pontoons and lowered to the bottom, the sand being removed by sand pumps whose operation is directed by divers. When the caisson reaches a gravel bed, 18 feet below the stream bed, the whole space inside the pier for the first 20 feet is filled with concrete, and the upper cylinder is then removed, leaving a level foundation 2 feet above the bottom and 31 feet in diameter. On this a brick pier is built, hexagonal in shape, 27 feet in the direction of the current and 16 feet in the direction of the bridge. This pier is built to a height of 22 feet on shore and floated into place. This height reaches above low water. Four 5 feet courses of ashlar carries the pier above high water, from which it is carried a farther height of 80 feet by six cast iron columns—four centre ones of 15 in. diameter, and two outer ones of 18 in. diameter. The riveted spans are built on shore, floated by pontoons on the top of the tides and deposited on the masonry piers 5 feet above high water. Thence they are raised by hydraulic power to 88 feet above high water, the pier of cast iron columns being simulaneously carried up.

About 500 men are at present employed on the undertaking, one of the larger spans being raised every month. The bridge is about two-thirds completed, and in point of time the contractors estimate the progress made as five sixths of the whole, much time being lost in the beginning on account of the largely experimental nature of the work. Ten spans yet remain to be erected and the bridge will probably be opened for traffic in one year.

THE annual report of Gen. Babcock, Engineer in Chief of the public buildings and grounds, District of Columbia, for the fiscal year ending June 30th, 1876, has been submitted to Gen. Humphreys, Chief of Engineers. It reviews at some length the work upon the public squares of the city and earnestly recommends the establishment of a National Zoological Garden (no joke intended) which he estimates to cost $200,000. The appropriation for the past fiscal year was exhausted and no appropriation was made for 1877. For the fiscal year ending June 30th, 1878 he submits an estimate of $340,858. The total consumption of water in Washington and Georgetown for the year past has been 24,177,797 gallons daily, or 165 gallons per head of population, the same being estimated at 146,000. He recommends measures to prevent the wastage of water, saying that additional distributing mains will soon be required if said waste is not stopped. He estimates that $1,028,194.07, including the appropriation of $350,000 for the present fiscal year, will be required to complete the east wing of the capitol building, and $201,134.63 to finish the approaches thereto. An estimate of $436,039.94 is submitted to commence work on the north wing next year.

WE commend to the careful perusal of our readers the very interesting article on the "Meteor of July Eighth," by Mr. Newman; we have not attempted to verify the calculations ourselves from want of time, but Mr. Newman has shown the way and whoever is not satisfied to accept his conclusions can work them out for himself. Certainly the results as given are of great general interest, and especially so as they have not heretofore been published. Mr. Newman has our thanks for his very able paper.

ON looking over an exchange in which our article of Aug. 26th, on the "Reported Low Pass at the Isthmus of Darien" is quoted, we find an error in the summit height of the Panama route. On referring to the article in question we find one of those vexatious typographical errors which is apt to make a man forget, for the time being, that he is the editor of an engineering journal. The compositor makes the height of the Panama summit 22 feet instead of 262 feet, as it should be, and this is probably the lowest pass across the Isthmus. The Nicaragua route was, however, decided as the most feasible of all the routes by the Canal Commission in Nov. last. In that connection the arrival of Don Amelio Benard, Minister from Nicaragua, to this country, after much delay, is anticipated with much interest by those who have devoted much attention to the proposed work. Upon his arrival negotiations will be entered into between our government and that of Nicaragua, looking to the construction of this canal, and treaties will be proposed to the principal foreign powers in the spirit of the Clayton–Bulwer treaty of 1850, guaranteeing the neutrality of the canal, etc. The estimated cost of the canal is $65, 722, 137, although many compenent engineers would increase this to $100 000,000. No trouble is anticipated in raising the funds to prosecute the work when once definitely ordered. Five years of hard work is the time estimated for its completion. The total length of the canal by the Nicaraguan route will be about sixty-one and three-fourth miles. To this is to be added sixty-three miles of slack water navigation by way of the San Juan river and fifty-six miles across Lake Nicaragua, making the total distance from ocean by lake, slack-water navigation and canal about 180¾ miles. The proposed canal will have ten locks in the western division, between Lake Nicaragua and the Pacific, including a tide lock at Brito, on the Pacific, to admit ships at any stage of the tide, each lock having a lift of about ten feet. In the eastern division, between Greytown and the mouth of San Carlos river, seven locks will be required. From the mouth of the San Carlos to Lake Nicaragua the navigation of the San Juan river is entirely practicable with three short sections of canal, each having one lock at Castillo, Ballas and Machuca.

THE total sum appropriated by the river and harbor bill is distributed as follows: New York, $548,000, of which $250,000 is for the Hell Gate improvement. Wisconsin, $444,000; Michigan, $387,000; West Virginia, $277,000; Texas, $247,000; North Carolina, $160,000; Ohio, $169,000; Virginia, $160,000; Oregon, $144,000: Georgia, $137,000; Indiana, $107,000; Minnesota, $100,000; Missouri, $99,000; California, $95,000; Maryland, $25,000; Massachusetts, $75,000; Arkansas, $72,000; Iowa and Illinois, $56,000 each; Pennsylvania, $63,000; Tennesee, $62,000; Delaware, $52,000; Rhode Island $45,000; Louisiana and Connecticut. $35,000 each; Vermont, $22,000; Maine and New Jersey, $20,000 each, and balance of the five millions distributed among other States in smaller amounts. It is well known that the President referred the bill to Gen. Humphreys with orders to revise it, authorizing only such expenditures as was absolutely necessary to keep existing works in repair and to carry works under construction to such a point of completion that they could be safely and economically left for a future day, completing only such as were absolutely necessary or extremely desirable, as such works, for instance, as those connected with the Hell Gate improvement. All new or projected works were to be ruthlessly stricken out. In accordance with the spirit of these instructions Gen. Humphreys, with the help of officers in charge of departments, has been engaged, since Congress adjourned, in revising the estimates, much to the chagrin of congressmen who had a creek to improve in their district. We understand that work has been ordered stopped on the Fox and Wisconsin river improvement. In the revised estimate $1,000 each is allowed for Chicago and Calumet harbors, and $15,000 to complete the superstructure of the cribs already in place at Michigan City. Those who were anticipating a government contract can now pocket their fists and look wise.

Engineering Instruments at Philadelphia.

Editor Engineering News.—We would like to add a few remarks to your valuable papers on "Engineering Instruments at Philadelphia." In the first paper the method of making, tempering and polishing steel caps for compass needles is given,—from the article however, one would infer that this method was new,—this is not the case. While all the instrument-makers in the United States outside of Philadelphia have been using the ruby or agate centres, the Philadelphia makers long since discovered the superiority of the steel ones and have used them for the last twenty years at least; in fact we have in our possession an old "Rittenhouse' Compass, which is almost a Centennial in years, which has one of these steel centres. Mention is made in the second paper of the "three levelling screw Transit" in our own exhibit,—this instrument on account of its resemblance to those used in Europe, and the radical changes we have made in the tripod details, has been more critically examined by European engineers than any other instrument we have on exhibition. In the tripod of this instrument, the aim has been to retain all the advantages of the "three levelling screw European form," without its cumbersomeness, and with the additional advantage of the American "shifting" arrangement. The credit of this device and its details does not however belong to us, but to Professor E. T. Quimby, of Dartmouth College, for whom the first one was manufactured.

While the exhibit of instruments by American makers, is not as full as it might be, what is exhibited, is of a high class of merit, and does not suffer by comparison with those of foreign make,

We have been amused at the astonishment of quite a number of European engineers at the display in this line, as some of them have had the idea that all the first class instruments of this class, used in this country were imported from Europe; and their astonishment was still further increased when they were informed that the export of these instruments to Europe, (which to the uniniated would seem a sort of "carrying coals to Newcastle,") was increasing every year.

Yours &c., Heller & Brightly.

Philadelphia, Sept. 8, 1876.

Chicago Wholesale Trade.

It is significant that the New York *Times* recently gave prominence to a letter from this city setting forth the reasons for believing that Chicago is to be the great jobbing centre of this country, and that a very large bulk of the wholesale business of New York will be transferred to this point. The suggestion of the letter was the location of a wholesale house in Chicago by the New York firm of A. T. Stewart & Co., and the fact that the views advanced were printed without comment from the New York interest seems to indicate an admission of the facts as not to be disputed. If there was no other sign of Chicago's commercial destiny than the circumstance that its business has gone on increasing steadily ever since the panic, while that of nearly every other city in the United States has been on the decline, this alone would be sufficient to warrant the conclusion that Chicago will take the lead as a commercial centre. The *Tribune's* last annual review showed the volume of business done in Chicago in 1875 to be $657,000,000, as against $639,000,000 in 1874—an increase of $18,000,000, notwithstanding the produce trade of the year had fallen off nearly 7 per cent. The increase in the wholesale trade and manufactures was 7 per cent over the previous year, which, allowing for the shrinkage in values, really amounted to an increase of 20 per cent in the volume of business done. The increase in the bulk of the dry-goods trade was estimated at fully 25 per cent. This year some decline was apprehended by the merchants, partly on account of the continued hard times and shrinkage in prices, and partly because it was thought the Centennial Exposition, likely to attract many visitors, might be the occasion of temporarily transferring a part of the Western purchases to Eastern cities. The result has proved both apprehensions to be unfounded. It is almost the universal testimony of the wholesale merchants that the business of the first half of the present year has been larger than that of the corresponding term in 1875, and the indications are that the fall trade will this year show a proportionate increase. However large the number of Western visitors to the Centennial may have been or shall be between now and the close of the Exposition, it has already been demonstrated that the advantages which Chicago possesses for the jobbing trade are so decided that an accidental visit to Eastern cities for pleasure or sight-seeing offers no inducement to country merchants to buy their goods there in preference to Chicago. These advantages may be briefly summed up in the central location of Chicago, its vast railroad connections, the enterprise of its merchants, adoption of the system of short credits, and the growth of a direct importation of foreign manufacture which makes a saving of from 1½ to 2 per cent on freights. The territory which Chicago naturally supplies is the richest and the sections naturally tributary to Chicago the most prosperous, in the country. The agricultural interests of the West, Northwest, and Southwest that look to Chicago as their metropolis, have been less affected by the hard times than any other interests in the country, and Chicago has enjoyed the benefit of their comparative prosperity.

If the jobbing trade is to give way in a large degree in the future to direct dealings between the manufacturers and the retail men, then Chicago will maintain the same advantages under the new order of things. This change will be slow and gradual, but the manufacturing enterprise of this city will keep in advance of it. From an article in the last number of one of our exchanges we recall some astonishing instances of the growth the city has already made as a manufacturing centre. Of the ten BESSEMER steel works in the United States, two are located in Chicago, and of the 291,000 tons BESSEMER steel rails made in the country last year, 85,000 tons, or nearly one-third of the entire amount, were made in Chicago. The iron industries have 200 establishments, employ 10,000 workmeu, and manufacture to the amount of $35,000,000 annually. The planing mills employ 4,000 laborers, and manufacture to the value of $10,000,000 annually. There are 75 furniture factories that employ 3000 skilled workmen, and make $6,000,000 worth of furniture annually. Chicago is said to take the lead of every other city in the Union in the manufacture of clothing, has the largest single factory in America, counts more than 25 establishments in all, and produces $10,000,000 worth of clothing a year. There are as many boot and shoe factories, which produce $3,500,000 worth of these articles annually; in one branch of this industry Chicago is already in advance of the old New England boot and shoe factory towns, and this has been an important auxiliary in the production of leather, which amounts to about as much more per year, and which has gained the reputation of being the best in the world. Other manufacturing interests are advancing in proportion, and *pari passu* with the growth of the jobbing trade within a circle of 100 miles are other and large manufacturing establishments whose market is Chicago, and which are owned and operated from this city.

The location of the STEWART house here is very properly regarded as a formal recognition of Chicago as the great centre of the wholesale trade of the country. This house saw that it must make the change in order to retain its share of the trade, and other great jobbers in dry goods and other lines must follow their example for the same reason. The Chicago house of A. T. STEWART & Co. can be in no sense a branch establishment. It will have to compete with one establishment doing nearly $20,000,000 of business a year, another doing nearly $17,000,000, and several doing from $2,500,000 to $5,000,000. It will be obliged, therefore, to transact business on the same large scale and in the same direct and independent way as in New York. It is reasonably estimated that, directly and indirectly, this change will add $10 000,000 to the volume of Chicago's trade the first year, and a proportionate increase thereafter. All the business and all the various interests of Chicago will receive a share of the increase it is sure to bring. The prospect of this has already made its impress. The business men are more hopeful, buoyant, and enterprising than ever. Real estate values and rents have been strengthened, and it is felt that the material and commercial progress of the city in the future will be more rapid than ever, notwithstanding the exceptional growth of the past, It has added a feeling of security and a confidence in the permanency and solidity of Chicago's business and growth among the people of the whole country,—a feeling that has always been cherished in Chicago in spite of all efforts to counteract it, and in spite of calamities and misfortunes, general and special. —*Chicago Tribune.*

Locomotives on Narrow-Gauge Railroads.

Mr. H. G. Brooks, president of the Brooks Locomotive Works, Dunkirk, New York, speaking of the importance of a proper distribution of weight, in order that the maximum weight upon any one point upon light rail may never exceed a given limit remarks:—

"Now I assert, as the experience resulting from a careful study of this question, that upon a 35-pound rail the weight upon a single point should never exceed three tons; and I also assert that if the weight is kept down to two and one-half tons upon a single point, the rail will only wear out from lateral abrasions, and will be practically indestructible from hammering and consequent lamination."

Again:—

"There is not the slightest difficulty in attaining and maintaining a speed of 30 miles per hour, if desired, with a diameter of driving wheel 36 inches. A very high velocity is not expected nor generally desired upon the narrow-gauge, and as the question of the elevation of the centre of gravity is really a most important one, driving wheels 36 inches in diameter will be found to give the best results in the end. Hence I do not hesitate to recommend a properly proportioned 'Mogul' locomotive with 36-inch driving wheels as the best and most economical for adoption for general traffic upon a narrow-gauge."—*Railway World.*

NOTES.

Forty-three steamships ply between Philadelphia and other ports.

London has 5,000 miles of gas-mains and upwards of 54,000 lamps.

The zinc mines at Friedensville, Pa., are believed to be inexhaustible.

The water in the St Lawrence River is this year two feet higher than usual.

A submarine telegraph cable has been laid between Nystad, in Finland, and the Aland Islands.

Montana's gold yield for the centennial year will surpass that of last year by a million or more.

New Bedford is contemplating a new high school-house at a cost of $120,000, including the land.

Finland, not to be outdone by the United States, is holding an Industrial Exposition at Helsingfors.

Lafayette Ind., has trouble with the operations of the crib in the river whence its supply of water is drawn.

Dalton, Mass., had a celebration Tuesday evening, Sept. 5th, in honor of the new iron bridge at the Center.

The English Parliament has recently passed a bill looking to the general introduction of the Metric System.

Some trouble in navigation is experienced on Lake Winnebago on account of the large amount of floating islands.

The permanent fund of the Smithsonian Institution has increased from $54,000 at the beginning of its career to $700,000.

The Japanese have arranged for an International Exposition, to take place shortly after that of France has closed.

The red granite from Charleston, S. C., for the new post-office and custom-house at Fall River, Mass., has begun to arrive.

Capt. Bradford, of the United States coast survey service, has commenced operations in charge of one of the three surveying parties on Puget Sound,

The building of the approaches to the Quinnipiac bridge, estimated at $15,000, and the West river bridges, $12,006, has been ordered by the New Haven Common Council.

The Corporation of Quebec, Canada, being about to purchase two steam fire engines invites manufacturers thereof, either in Canada or the United States, to compete at a trial in Quebec on the 20 and 21st of this month.

The defective portion of Fullerton avenue conduit extending under the lake is now being repaired and strengthened by turning an extra ring of brickwork on the inside. An inspection of the work at present will show how work ought not to be done.

Another State is talked of. It is proposed that California shall be cut in two along the line of Santa Cruz county, with fourteen southern counties for a new commonwealth, which will have about 150,000 inhabitants, and taxable property estimated at $100,000,000.

Few persons not familiar with geography will believe that the Pacific ocean boundry of the United States has a greater extent of coast line than the Atlantic shore. The aggregate of shore line on the Pacific is 12,734 miles, while on the Atlantic it is 11,860 miles, aud on the Gulf of Mexico 6,843 miles.

The yew trees of Britain are of wonderful longevity. One lived at Fountains Abbly, Ripon, for 1,200 years. There are some yews at Crowhurst, in Surrey, 1,400; a yew at Fontigal, Perthshire, 2,000 or 2,600; a yew at Bradburn Kent, 3,000, and a yew at Hedso, Bucks, twenty-seven feet in diameter, 2,300 years.

Prof. T. C. Chamberlain, chief geologist of the State, after surveys this summer on the Wisconsin shore of the St. Croix river, is of the opinion that the copper-bearing rock extends south into Polk, Burnett, Barron and St. Croix counties; and probably that the iron range instead of bearing over into Minnesota, tends southward in Wisconsin, toward the Black River range.

Telluric ores have been discovered at a depth of two hundred feet near Charlotte, North Carolina. Tellurium belongs to the sulphur and selenium group of metalloids. and its presence in any part of the country is well worthy of notice, especially to those interested in gold mining, as it is considered by experts to be an undoubted evidence of large deposits of rich ore.

Buffalo is contemplating the adoption of a new automatic fire telegraph by which the fire is compelled to announce its own existence and precise location. The signal is communicated by means of small brass tubes or heat detectors placed on the ceiling, twenty feet apart, of each room in the building, all being connected with wires that run through a signal box on each floor, thence to the main circuits that leads to the receiving office.

Mr. A. S. Holly writing upon "The Inadequate Union of Engineering, Science and Art," says there is also a class of practicians who do secretly and abstractly respect the labors of the scientific investigator, and are unwillingly governed, more or less, by his conclusions; but their minds are so barren of general facts and so untrained in the scientific methods of utilizing facts and, hence, so distrustful of any ideas which reach beyond their own practice, that they, also, are impediments rather than helpers in the union of science and art.

One of the great internal improvements of Sweden is the Gotha Canal. The object of it is to connect, by short route, the waters of the Baltic and the North Sea. This is done by means of a channel which has been cut between seven lakes, and which unites them with the seas. This canal was twenty-two years in building and cost several millions of dollars. At one point it attains an elevation of 308 feet above the level of the ocean. Gothenburg on the west coast is in close connection with this canal. It has a population of at least 60,000, and excels the capital in point of commerce.

The Vienna Academy of Science has addressed to the scientific societies of Europe a circular, accompanied with an instructive report, inviting them to unite in observations having for their object a determination of the cause of the decrease of water in springs, rivers and water-courses. Attention is called to the fact that, for a certain number of years, the waters of the Danube and other large rivers have been diminishing. The Austrian engineers and Architects' Union have taken up the same question and have appointed a Hydrostatic Commission to collect facts and prepare a report. Two members will observe the Danube, the Elbe and the Rhine, and two others will study the meteorology of the subject and the influence that the Alpine glaciers and torrents may bear upon it. The commission regard the devastation of the forests as the prime cause of the disastrous decrease of European waters, and urge an immediate adoption of measures to remedy the evil.

The Portland *Oregonian* of Sept. 1st, says: There are now four steamers plying on the Upper Willamette river, the W. T. & L. Company having three, the *Occident*, *Orient* and the *Bonanza*, and the Independent line one—the *City of Salem*. The locks are also being dredged and otherwise improved, the company owning them, no doubt wishing to place no obstacle in the way. but rather inviting outside parties to take their boats through the locks. The principal difficulty encountered by the boats plying between Portland and Salem are the immense snags and sunken logs which are generally found to collect at the very worst places, and are very annoying to pilots. The owners and managers of the different ware and storehouses on the river are now receiving grain in great quantities. The Farmers' warehouse at Lincoln receives about 1,000 bushels daily. Others at more or less convenient stations, in proportionate quantitiss. The Government contractors for the construction of wing dams are at work at Buena Vista Bar and at Pine Tree Rapids (Willamette river). The work at the former place is conducted with much difficulty, owing to the strong current which washes away not only the sand and rocks put on top of the brush as fast as the men place it in position, but even the piles driven to a depth of five or six feet. So far the work at that place has not improved the channel.

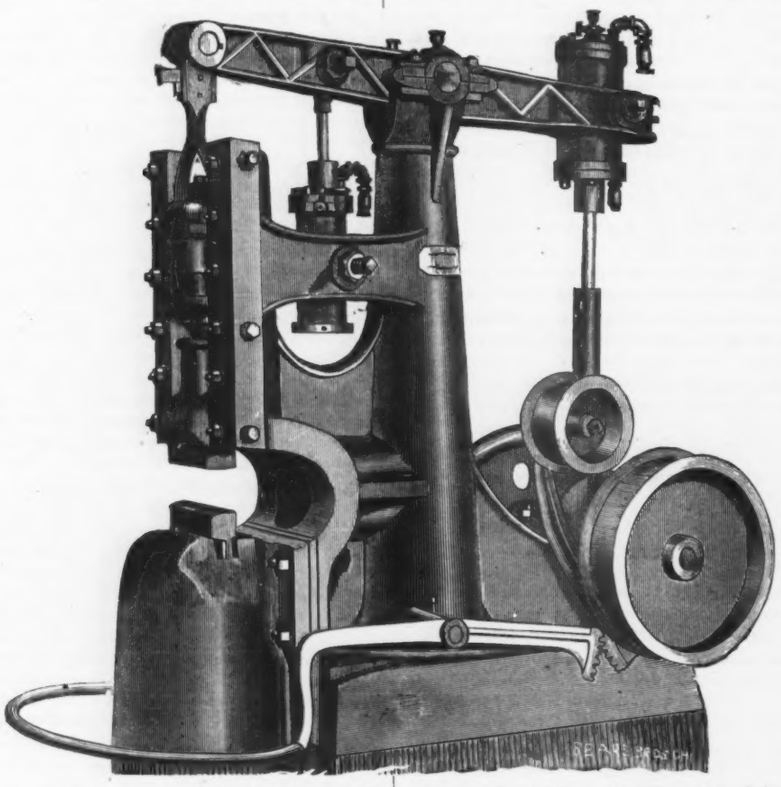
Butterfield's Atmospheric Hammer.

We illustrate this week something new in the already numerous family of forging hammers.

The inventor is J. C. Butterfield of Chicago, and the patent is for "Improvement in Atmospheric Hammers," dated April 6, 1876. A hammer built under this patent is now on exhibition at Philadelphia, and several peculiarities in the design merit description.

Atmospheric hammers have heretofore been constructed and their characteristics may be classed as follows: *a*, atmospheric pressure added to the weight of the hammer to increase the impact; *b*, expansion of compressed air to increase the impact; *c*, compression above and below the piston, the former to elevate the hammer, and the latter to increase the impact; *a* and *c* also propose to regulate the force of the blow by air cushioning; *a* and *b* elevate the hammer by mechanism; *c* elevates by compressed air.

A principle desideratum in all power hammers, is to intercept the shock of the hammer-blow, from the framing. This has been attempted by the interposition of a body of air between the hammer and its motive mechanism, which device has failed owing chiefly to the rigidity of the packings. In this hammer cushions of india rubber are interposed, so that at no point does any part of the motive mechanism come in metallic contact with any adjuncts of the hammer, thus effectually preventing the transmission of any shocks to the framing or mechanism, or lateral vibration to the hammer rod.



The hammer head and attachments are connected to one end of an oscillating beam mounted near its centre, to the other end of which is attached an air cylinder mounted on centre screws, in connexion with which the driving mechanism operates. The weight of the driving mechanism and attachments counterbalances that of the hammer-head and attachments, so that the power necessary is a minimum, no dead weight being lifted, power only being required to overcome the friction, inertia, and the trifling loss in the air cylinders. The beam itself as are all the moving parts, is of crucible steel, of minimum lightness consistent with strength, which is accomplished by flangeing and diagonal trussing. The whole machine weighs about 3700 lbs., and the weight of the hammer head is 100 lbs. By means of an idler pulley operated by a treadle, any speed may be given up to 300 blows per minute, and the intensity of the blows may be regulated through the medium of the air cylinders. The throw of the eccentric is about 1½ in., giving an 8 in. throw to the hammer The throw of the eccentric, however, can be quickly adjusted by means of a set screw, thus giving another method of regulating the blow of the hammer.

The general arrangement and function of the various parts may be seen on reference to the engraving. The operation of the cylinder is as follows: The piston rod is connected directly with the eccentric by means of an an adjustable sleeve joint. The cylinder is 12 in. in length provided with a vent hole in the middle, and simple check valves at each end, opening inward. When the piston descends the compression of the air in the bottom of the cylinder begins as soon as the piston passes the vent, and the cylinder will begin to descend and the hammer to rise as soon as the compression is sufficient to overcome the inertia and friction of the moving parts. When the movement of the piston is reversed, expansion of the compressed air and momentum will cause a continuation of the upward motion of the hammer, which will be checked by compression of the air in the top of the cylinder as the piston moves upward, and the hammer will thereby be driven down upon the anvil, the intensity of the impact, being proportional to the rapidity of the reciprocation of the piston. As the eccentric passes its lower centre, the weight of the piston, its rod and attachments, is sustained by the compressed air in the front cylinder, thus relieving the eccentric of thrust in reversing the motion. The same effect in a reverse direction takes place as the eccentric passes its upper centre.

To counteract the constant upward thrust upon the fulcrum of the reciprocating beam, a supplemental cylinder of smaller calibre is added on the opposite side, acting in opposition to the main cylinder, but in quite a similar manner.

The piston is nearly half the length of the stroke, thus securing greater compression if desired, the degree of this compression being regulated by means of the check valves. By a proper adjustment of this air cushioning all upward thrust of the beam journals against the boxes may be prevented, thus doing away with jar in the operation of the beam. In atmospheric hammers heretofore constructed it has been impossible to regulate the force of the blow except by alteration of the speed. By adjusting the lower check valve at the bottom of the second cylinder, the air may be made to take up the force of the blow without reference to the speed.

The parts claimed as new, are the devices for preventing jar at the hammer, the oscillating hammer beam, the eccentric acting through the medium of the main air cylinder, the main air cylinder, the secondary air cylinder, the treadle and the belt tightener.

We have witnessed the operation of the hammer and must say it works with remarkable ease and smoothness and that no jar except that due to the anvil block could be detected. The fact that no check nuts are used and that no nut has worked loose is good proof of this. It is undoubtedly a reliable and efficient hammer requiring the minimum of power to drive it.

Henderson (Ky.) Water Works.

BY GASTON M. ALVES, ENGINEER.

[Written for Engineering News.]

Our Water Works which have recently been completed may be generally described as follows:

The machinery is located at the upper portion of our city, and pumps the water into a reservoir some 1100 feet back from the river, from whence it is distributed to the city through pipes. Upon the banks of the reservoir there is a stand pipe 5 feet in diameter and 80 feet in hight, to be used in cases of fire.

ENGINE PIT.

The engine pit is situated on the river bank between the bluffs and the water, and is founded upon a thick indurated stratum of soap stone. The floor of the pit is 8 feet above extreme low water. The dimensions of the pit are 8 by 15 by 39 feet in depth; the top being 3 feet above extreme high water. The walls of the pit are 9 feet in thickness at the bottom, battering up on the outside so as to give a thickness of 4 feet at the top. The masonry is composed of regular coursed sandstone; no course less than 16 inches. The inside of the pit as finished presents an even and neatly dressed surface.

The outside is finished with rough faces with neat draught. The method of construction was as follows: After a course of masonry was laid, the top surface was brought to a level; the spauls were thrown into the interstices of the block of stone composing the course, and then the whole well grouted flush to the top. The next course with beds well and evenly dressed were then laid upon cement mortar and proceeded with as above. In no case was a cross joint allowed to run through the wall. The work was carefully and faithfully done, and yet during very high water, the water came into the pit at the rate of a little over one ¼ inch per hour. So much for grouts. At present however the embankment around the engine pit has about effectually obviated the leakage.

MACHINERY.

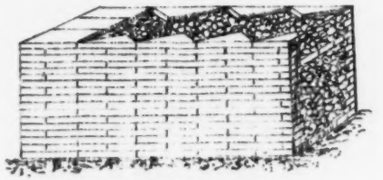
In our advertisements for machinery we described a condensing engine, but otherwise very similar to that hereinafter described. Finding the bids greater than we felt able to pay on the original machine, we accepted the following:

Two single acting plunger pumps 14 inches in diameter and 5 foot stroke, connected by means of a heavy walking beam. Upon the floor of the engine house (top of engine pit) sits a 19 inch non-condensing engine immediately over one of the pumps. The fly wheel 10 ft. in diameter and 12 tons in weight, is situated in the pit, and of course below the engine house floor. The suction main is 12 inches in diameter and 300 feet long.

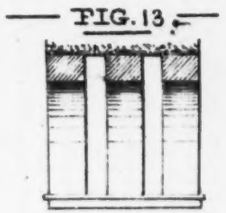
The contract stipulated that the pumps, at 13 revolutions per minute, should elevate into the reservoir, a hight of 148 ft. above the floor of the engine pit, through a 12 inch force main 1100 feet in length, 1,500,000 U. S. gallons of water in 24 hours.

As constructed, the machinery failed to do the work; worked badly, and pounded considerably. It was then thought that the cause was owing to the fact that the air vessel was too far above the valves. To remedy this the contractors raised the dome of the valve chamber, thereby creating in same an additional air vessel, and connected therewith an air pump to supply it with air. This improved the working of the machine, but did not give the required satisfaction. The contractors then put an air vessel upon the suction main, and connected therewith the air pump, which proved to be the thing needed. The machinery then gave satisfactory results.

This experience is the same as that at New Albany, Ind. Their machinery being very similar to ours—had the same trouble, and remedied it in the same manner

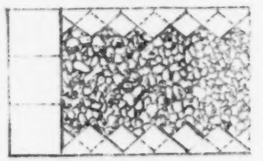


— FIG. 9. —



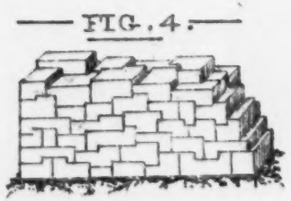
— FIG. 13. —

— FIG. 10. —

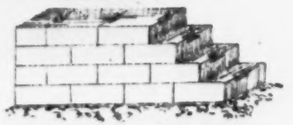


— FIG. 2. —

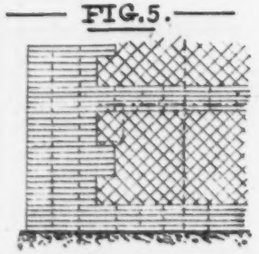
— MAP —



— FIG. 4. —

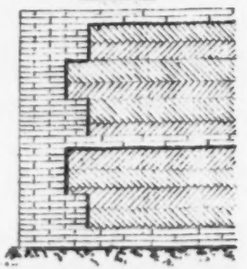


— FIG. 3. —

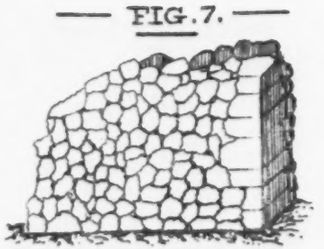


— FIG. 5. —

— FIG. 6. —

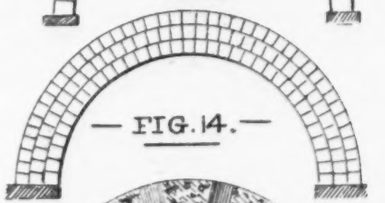


— FIG. 8. —



— FIG. 7. —

— FIG. 11. —



— FIG. 14. —

— FIG. 12. —

viz.,—with air chamber to suction.

RESERVOIR.

The reservoir is rectangular in shape, with inside slope of 1½ to 1 and outside slopes of 1¾ to 1. Capacity 2,750,000 gallons, and is situated at an elevation of 70 feet above the business portion of the city, and 148 feet above the engine pit floor. It is partly in cut and partly in fill. The inside slopes are covered with clay puddle 2 feet in thickness, upon the top of which is a 9 inch lining of hard brick laid in cement mortar. The bottom is covered with 18 inches of clay puddle, upon the top of which is 5 inches of concrete made from broken bats and cement mortar. The entire embankment was watered and rolled during construction. The excavation of the bottom of the reservoir is in sand, which occasioned us some trouble and considerable anxiety when water was first let in, as the water soaked out to an alarming extent through the puddle into the sand. The evil however tended to its own correction, and now after some four months the leakage is reduced to a very insignificant amount. We should have excavated to a certain uniform depth into the sand, and replaced the same with stiff red clay well packed.

PIPES.

Specified weights of pipes were as follows:

12"	length	12'	5"	weight	1055	lbs.
6"	"	"	"	"	420	"
4"	"	"	"	"	300	"

Besides the above the weight of the 12" for the force main was 1136 lbs.

The pipes stood the stand pipe pressure (70 lbs.) without breakage, and with very few leakages at the joints.

STATEMENT OF COST.

Engine pit work, $8.19 per cubic yard	$ 7,748 44
Machinery	15,400 00
Reservoir Excavations 20 cts. per yd., Clay Puddle 65 cts. per yd., Brick Masonry $7.25 per yd., Stone Masonry $9.80 per yd., Concrete $6.25 per yd.	10,700 55
Pipes and Specials. Pipes $47.85 per ton, Specials $75.00 per ton	30,080 39
Pipe Laying. 31 cts. for 12 in., 24 cts. for 6 in. and 20 cts. for 4 in.	5,378 70
Stand Pipe	2,500 00
Land	7,500 00
Buildings	3'500 00
Valves. 4 in. $20., 6 in. $32., and 12 in. $73	937 00
Fire Hydrants $31	713 00
	$ 84,158 08
Incidents	10,000 00
Total	$ 94,158 08

CONTRACTORS.

Engine pit work—Jno. G. Eigenman, Rockport, Ind.
Machinery—G. B. Allen & Co., St. Louis, Mo.
Reservoir—Jno. Hafley, Henderson, Ky.
Pipes and specials—R. D. Wood & Co., Philadelphia.
Pipe laying—Jno. Haffey, Henderson, Ky.
Thos. J. Whitman, St. Louis, Mo., Consulting Engineer.

The Meteor of July Eighth.

BY JOHN NEWMAN C. E., Mansfield, O.

[Written for Engineering News.]

The method of estimating the hight, velocity and direction of the meteor of July 8, 1876, has not been discussed in any of the articles that have come under my observation.

Among the numerous observations I consider the one made at Chicago, Illinois, and first published in the Chicago *Tribune*; the other made at Mansfield, Ohio, and first published in the Mansfield *Herald*, to be the most specific and accurate, after being slightly corrected by a combination with observations made at other places.

We take the elements of the meteor for its first appearance.

For Mansfield we have, Latitude $= l = 40° 44'$ North, Longitude $= L = 5^h\ 30^m$ west from Greenwich, right ascension of meteor $11^h\ 50^m = a$; declination $\delta = 50°$ North, astronomical time of observation $9^h\ 4^m$. For Chicago we have Latitude $= l^1 = 41° 52'$ North, Longitude $= L^1 = 5^h\ 50^m\ 20^{sec.}$ west from Greenwich; right ascension of meteor $20^h\ 26^m = a^1$, declination $\delta^1 = 5°$ North, astronomical time of observation $8^h\ 44^m$. As the elements are only a rough approximation, I will use five figure logarithms and take the results to the nearest minute, this being a degree of accuracy equal to the observations.

By drawing a line from the meteor to the north pole and from the pole to the zenith, and calculating the hour angle from the observed time we have the elements of a spherical triangle by which we can calculate the zenith distance of the meteor at both stations.

For the hour angle at Mansfield we have,

Nautical Almanac	T =	9^h	4^m	$0.00^{sec.}$
	V =	7	7	7.27
	T + V =	16	11	7.27
Correction for T + V + L =			−2	4.34
	Θ =	16	9	2.93
	a =	11	50	0.00
West, $64° 45' = t = \Theta - a$ =		4	19	2.93

For the hour angle at Chicago we have,

	T =	8^h	44^m	$0.00^{sec.}$
	V =	7	7	7.27
	T + V =	15	51	7.27
Correction for T + V + L^1 =			−2	7.27
	Θ =	15	49	
	a^1 =	20	26	

East, $69° 15' - t = \Theta - a = -4\ 37$

With this data we can calculate the zenith distance of the meteor at Mansfield and Chicago by the equation;

$$\cos z = \sin l \sin \delta + \cos l \cos \delta \cos t \qquad (1).$$

In which z is the zenith distance, l the latitude, δ the declination and t the hour angle of the meteor. For logarithmic computation we have,

$$m \sin M = \sin \delta$$
$$m \cos M = \cos \delta \cos t$$
$$\tan M = \frac{\sin \delta}{\cos t \cos \delta}$$
$$\cos z = m \cos (l - M)$$

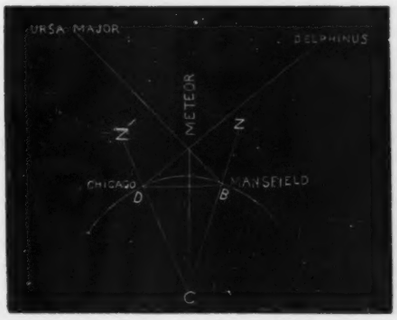
For Mansfield we have by the elements and equation (1).

$\log m \sin M = \log \sin \delta$	9. 88425
$\log \cos \delta$	9 80807
$\log \cos t$	9. 62999
$\log m \cos M = \log \cos \delta \cos t$	9. 43806
$\log \tan M = \log \frac{\sin \delta}{\cos \delta \cos t}$	0. 44619
M	70° 14'
$\log \sin M$	9. 97363
$\log m$	9. 91062
$\log \cos (l - M)$	9. 93970
$\log \cos z = \log m \cos (l - M)$	9. 85032
Z	44° 53'

For Chicago we have by the elements and equation (1).

$\log m^1 \sin M^1 = \log \sin \delta^1$	8. 94030
$\log \cos \delta^1$	9. 99832
$\log \cos t^1$	9. 54936
$\log m^1 \cos M^1 = \log \cos \delta^1 \cos t^1$	9. 54768
$\log \tan M^1 = \log \frac{\sin \delta^1}{\cos \delta^1 \cos t^1}$	9. 39262
M^1	13° 52'
$\log \sin M^1$	9. 37960
$\log m^1$	9. 56070
$\log \cos (l^1 - M)$	9. 94593
$\log \cos z^1 = \log m \cos (l^1 - M)$	9. 50663
Z^1	71° 16'

By connecting Mansfield and Chicago by a great circle and drawing lines from each place of observation to the meteor and to the centre of the earth we have a quadrilateral as shown in the following diagram which is drawn for illustration with no pretensions to accuracy.



Z, Z^1 is the zenith of Mansfield and Chicago; take the arc DB $= b$, the chord DB $= c$, CD $=$ CB $= r = 3{,}956$ miles. DA $= d$, BA $= e$, AC $= x$, angle DCB $= m$, and is measured by the arc b, BDC $=$ CBD $= n$, since CB $=$ CD $= r$, DAB $= M$, which is the angle of parallax, DAC $= q$, BAC $= p$, and $q + p = M$. DCA $= o$, BCA $= s$, ADB $= f$, ABD $= g$, $o + s = m$.

Having the latitudes of Mansfield and Chicago and their difference of longitude $L^1 - L = 20^m\ 20^{sec.}$ or in arc $5° 5' = u$, we calculate the arc b, which measures the angle m, by the equation.

$$\cos b = \sin l \sin l^1 + \cos l \cos l^1 \cos u \qquad (2).$$

For logarithmic computation we have,

$$k \sin N = \sin l^1$$
$$k \cos N = \cos l^1 \cos u$$
$$\tan N = \frac{\sin l^1}{\cos l^1 \cos u}$$
$$\cos b = k \cos (l - N)$$

$\log k \sin N = \log \sin l^1$	9. 82439
$\log \cos l^1$	9. 87198
$\log \cos u$	9. 99829
$\log k \cos N = \log \cos l^1 \cos u$	9. 87027
$\log \tan N = \log \frac{\sin l^1}{\cos l^1 \cos u}$	9. 95412
N	41° 59'
$\log \sin N$	9. 82537
$\log k$	9. 99902
$l - N$	−1° 15'
$\log \cos (l - N)$	9. 99990
$\log \cos b = \log k \cos (l - N)$	9. 99892
b	4° 2'

By subtracting the zenith distance at Mansfield and Chicago from 180°, we have the angles as follows:

ABC =	135° 7'
ADC =	108° 44'
m =	4° 2'
Sum	247° 53'

This deducted from 360°, leaves the parallactic angle $M = 113° 07'$.

The angle $n = \frac{180° - 4° 2'}{2} = 87° 59'$; $g = 135° 7' - 87° 59' = 47° 8'$; $f = 108° 44' - 87° 59' = 20° 45'$.

In the triangle BCD, to find c,

$\log \sin n$	9. 99973
$\log \sin m$	8. 84718
$\log r$	3. 59726
$\log c = \log \frac{r \sin m}{\sin n}$	2. 44471
c	278.4

In the triangle ABD, to find e and d.

$\log \sin M$	9. 96365
$\log \sin g$	9. 86507
$\log \sin f$	9. 54936
$\log \sin c$	2. 44471
$\log e = \log \frac{c \sin f}{\sin M}$	2. 03042
e	107.3
$\log d = \log \frac{c \sin g}{\sin M}$	2. 34613
d	221.9

In the triangle ADC, we have two sides and the included angle to find q, o and x, we have for this purpose the equations, $\tan \Phi = \frac{r}{d}$

$$\tan \tfrac{1}{2} (q - o) = \tan (\Phi - 45°) \tan \tfrac{1}{2} (q + o)$$

$\log d$	2. 34613
$\log r$	3. 59726
$\log \tan \Phi = \log \frac{r}{d}$	1. 25113
Φ	86° 47'
$\log \tan \frac{1}{2} (q + o)$	9. 85540
$\log \tan (\Phi - 45°)$	9. 95113
$\log \tan \frac{1}{2} (q - o)$	9. 80653
$\frac{1}{2} (q - o)$	32° 28'
$\frac{1}{2} (q + o)$	35° 28'
o	3° 00'
q	68° 16'

In the triangle ACD, we have r, d, and the angle to find x.

$\log d$	2. 34613
$\log \sin o$	8. 71880
$\log \sin z$	9. 97636
$\log x = \log \frac{d \sin z}{\sin o}$	3. 60369
x	4015.1
r	3956.0
$x - r$	59.1, miles *which was the hight of the meteor above the surface of the earth.*

Distance of meteor from Mansfield 107.3 miles.
" " " " Chicago 221.9 "
" " " " surface of the earth 59.1 miles.

The meteor described an arc of 45° during its visibility, which was estimated at four seconds; its distance through the atmosphere was about 60 miles which would make the average velocity 15 miles per second.

The new comer was evidently a small asteroid that had been revolving around the sun in an elliptical orbit; and if we knew the length of its major axis, we could calculate its exact velocity by the equation $V^2 = \mu \left(\frac{2}{r} - \frac{1}{a}\right)$, from Bowditch's La Place, vol. 1 page 393; but taking into consideration its angular motion and the velocity of the earth, which was 18 miles per second, and at the same distance from the sun, we find the velocity in its orbit was about 20 miles per second

The motion and revolution of the earth would conspire to increase this velocity, while the friction of the atmosphere would retard it, and at the hight of 59.1 miles the atmosphere would be so rare that uniting all the elements named above, we may conclude that the velocity through the atmosphere was uniform retarded; so that we may take $\frac{20+x}{2} = 15$, or 10 miles per second for its velocity, after passing through the atmosphere. The query now naturally arises why did it not fall to the earth since from its loss of motion it cannot maintain its elliptical orbit.

We learn from Mechanics, that gravity varies in the inverse rato of the square of the distance, hence if we take g for the force of gravity at the earths surface, and φ its force at any other distance x, we have

$$\varphi : g :: r^2 : x^2$$

$$\text{or } \varphi = \frac{gr^2}{x^2};$$

and giving to φ, the negative sign, since the force being directed towards the origin tends to diminish the distance we have for the body's motion

$$\frac{d^2x}{dt^2} = -\frac{gr^2}{x^2} \qquad (3).$$

Multiply both sides of equation (3) by $2\,dx$ and

$$\frac{2\,dx\;d^2x}{dt^2} = 2gr^2\,\frac{dx}{x^2}.$$

Integrate and we have

$$\frac{dx^2}{dt^2} = 2gr^2\,\frac{1}{x} + C = v^2$$

To determine the constant C, we will suppose that the body begins to move from the distance a, and at that distance $v = o$; put $x = a$, in equation (3) and we have

$$2gr^2\,\frac{1}{a} + C = o$$

$$\text{or } C = -2gr^2\frac{1}{a}$$

Put this value of C, in (3) and we have finally

$$\frac{dx^2}{dt^2} = 2gr^2\,\frac{1}{x} - 2gr^2\,\frac{1}{a}$$

$$\text{or } \frac{dx^2}{dt^2} = v^2 = 2gr^2\left(\frac{1}{x} - \frac{1}{a}\right) \qquad (4).$$

Equation (4) will give the velocity of any moving body acted on by the earth's gravity at the distance x, from the centre of the earth or $a - x$, from the point from which the body begins to move.

If we make $a = \infty$, which puts the body beyond the earth's attraction, we have $v = (2gr)^{\frac{1}{2}} = 6.95$ miles per second.

Therefore the meteor being 59 1 miles from the earth's surface, and having a velocity of ten miles per second, could not fall to the earth; but if its motion after clearing the earth's atmosphere was directly towards the sun, it would fall to the sun; otherwise it would find another elliptical orbit and still continue to revolve around in this new orbit.

Having arrived at a knowledge of the distance of the meteor from the places of observation, if we knew its angular diameter, we could calculate its real diameter with great precision.

The world-renowned electrician D. M. Cook, residing near Mansfield, saw the meteor, and estimates its diameter from its luminosity.

Mr. Cook has had great experience in the comparison of electrical with other lights by means of Photometers.

He compares the light of the meteor at the distance it was from him, one hundred and seven miles; as being equal to an electrical light from one of his *new* and powerful batteries placed at the distance of one hundred feet, and having a *voltaic arc* one half inch in length.

He increases this electrical light in the ratio of the square of the distance, making the proper allowance for the loss of light from the meteor, by the absorption of the atmosphere; he has then the light of the meteor in its own neighborhood, equal in round numbers to 25,000,000 electrical lights of the capacity above stated.

The bulk of the meteor would be in a geometrical ratio to that of the electrical light; and an incandescent body like the meteor, to throw out this enormous amount of light, must have been not less than sixty feet in diameter.

The contractor on a road which is being built at Seattle, Oreg. having drawn a portion of the price for the job, left his workmen with their wages due, and has gone to "furrin" parts.

The Dimensions of Narrow Gauge Railroads.

BY GEORGE PAUL, C. E.

CHAPTER IV.

LOCOMOTIVES.

In beginning this work it was not our intention to treat upon rolling stock, but we find it advisable to introduce a few remarks upon the locomotive engine. In the preceding pages we have shown how to determine the resistance to be overcome in hauling a train upon a level and upon curves and grades at any speed; and in order to show what the necessary dimensions of the parts must be to sustain the engine required to haul the freights against such resistance, we must first determine what the size of the locomotive must be. This is of the utmost importance, because it is almost unavoidable that the locomotive be constructed otherwise than so as to produce a greater strain upon the sub and superstructure of the road than any of the rest of the train; and for this reason the portion of the road must be built to resist the strains caused by the passage of the locomotive over it.

To accomplish a certain work, it is necessary that the locomotive have boilers of capacity to generate steam in quantities enough to operate the engines, and that these engine cylinders have sufficient area of piston to be operated with the pressure safe to work the steam in the boiler. It is also necessary that the engine have ample weight upon the drivers to enable them to adhere to the rail with a tenacity such as will prevent them from slipping when hauling the train.

By reference to chapter on grades, it may be seen that the necessary power to overcome or haul a train upon a track having grades of 52.8 ft. per mile, or a rise of one foot for each station of 100 feet, is as follows:

Friction,	7	lbs.	per	ton.
Gravity,	20	"	"	"
Speed,	0.84	"	"	" 12 miles per hour.
Total,	27;84	"	"	"

Supposing the total weight of train to be 145 tons, the total traction power required to run it would be $27.84 \times 145 = 4{,}036$ lbs. In this instance it is supposed that the locomotive required to haul this train is one of the ordinary type of passenger engines, having drivers 40 inches in diameter and cylinders of 16 inch stroke, it will be necessary to determine the weight upon drivers necessary for adhesion, the diameter of cylinders, the area of heating surface, also the area of grate surface. The weight necessary to give the parts resting upon the drivers sufficient adhesion to draw the train ranges from three to eight times the horizontal force to be exerted; but with sand the track can be put in such condition that five times the tractive force is sufficient weight to put upon the drivers for adhesion; and in this instance we find $40{,}000 \times 5 = 20{,}500$ lbs., or ten tons, to be the required amount. Having found the weight upon drivers, it is next desirable to find the heating surface necessary to generate steam. Upon the common gauge it is not an uncommon rule to give 50 feet of heating surface for each ton on drivers available for adhesion; in accordance with this rule the heating surface required would be 500 feet. But the Baldwin Locomotive Works use only a surface of from 35 to 40 square feet for each ton upon driver; Messrs. Porter, Bell & Co., of Pittsburgh, use about the same. The greater of these quantities would give 400 square feet for the area of heating surface with ten tons of weight on drivers. The above rule is one which might vary under so many circumstances, and is of no value under changes of speed, consequently the following rule is introduced, and believed to be original with the author:

RULE TO FIND HEATING SURFACE.—Multiply total traction force at the rail by speed in miles per hour, and divide by 120 for passenger engines and 110 for freight engines, and the result is the number of square feet of heating surface required.

Example: Traction force 4,000, speed 12 miles per hour—$4{,}000 \times 12 \div 120 = 400$ feet of heating surface.

The area of grate surface varies in proportion to the heating surface much more than might be supposed. In the beginning of the agitation upon the gauge question it was strongly urged by many that a correct or true proportion between the grate area and heating surface could not be maintained upon a gauge of less width than the ordinary gauge, and to obtain this proportion under the best circumstances the 5 ft. gauge should be resorted to. It was urged that to obtain the relative proportion between grate area and heating surface the fire-box would have to be too long for its width. The locomotives of the 4 ft. 8½ in. gauge on exhibition at the Centennial show the average proportion of length of fire-box to breadth to be 2.82 to 1; where the gauge is 3 ft. we find the proportion to be as 2.1 is to 1, when the Farlie engine, built by Mason, is included. Omitting this one the proportion still is as 2.3 to 1, showing that the designers upon the ordinary gauge do not consider it of sufficient importance to avail themselves of the proportions claimed of such great importance. The general proportion of grate area to heating surface ranges from one-fiftieth to one-sixty-fifth, and there are instances in which this is either not enough or too great, and one-fifty-fifth may be taken for a fair average—$400 \div 55 = 7.27$ square feet of grate area. A rule in common use is to multiply diameter of cylinder by 0.77. When diameter is 10 inches the area should be $10 \times 0.77 = 7.7$, or one-half a foot greater than by the other rule.

In estimating the diameter of the cylinder, the pressure required to move the drivers must be determined, the piston speed being slower than that of the periphery of the drivers in proportion of the circumference of the drivers 126 inches to the double stroke of the piston 32 inches; the pressure upon the pistons required to move the drivers is the inverse ratio of their circumference to the travel of the piston, and may be found by multiplying the tractive force required to move the train by circumference of drivers and dividing by double the stroke of piston.

Example: Traction force, 4,000; circumference of driver, 126; double stroke of piston, 32—$4{,}000 \times 125 \div 32 = 15{,}705$.

This is the pressure of steam in pounds requisite to move the pistons, and estimating the effective pressure of steam at 80 lbs. per circular inch, we find the number of circular inches requisite to be $15{,}750 \div 80 = 197$ inches. This is the area required for both pistons, and to determine the diameter divide by 2 and extract the square root—$\sqrt{197} \div 2 = 9.92$ inches; this being but 0.08 less than 10 inches, it may be taken at that figure. The dimensions arrived at by this line of reasoning laid down, are: Weight on drivers, 20,000 lbs.; heating surface 400 square feet; grate area, 7.27 square feet; cylinder, 10x16. The diameter of drivers and stroke of piston have been assumed, because the same piston speed will be obtained from this proportion that the 24 inch stroke of piston reaches with 5 feet drivers upon the common gauge, and these are not uncommon proportions. The rules laid down to find the dimensions given are not such that they cannot be varied from, but they are such that they will determine the dimensions of engines that are built and in common use upon this gauge. A higher pressure of steam would permit a less diameter of piston, and circumstances might vary either the quantity of heating surface or the proportion of heating to grate surface without materially affecting the efficiency of the machine.—*Railway Review.*

ERRATA:—In Chapt. III. 1st paragraph below RULE 8;—"For net tons we use one pound less,"—read—"For net tons we use seven pounds"—[ED.]

Railway News.

Seventeen new engines, ordered for the Texas Pacific, have been delivered.

The Southern Pacific and the Cincinnati Southern Railways are the longest lines now under construction.

The total mileage of railroads in Indiana is 3,905 miles, and the total assessment of property is $38,294,513.

The extension of the Omaha and Northwestern Railway from Herman, Neb., seven miles to Tekamah, forty-seven miles from Omaha, is completed.

The Portland and Rochester Railroad Company, Me., are putting a pier under the long span of their bridge where it crosses the Saco river at Bar Mills.

Up to this week there has been 1,388 miles of railway completed in the U. S. in 1876 against 678 miles for the same period in 1875, 984 in 1874, 2,408 in 1873 and 4,264 in 1872.

A surveying party has been put on the proposed Oregon line of the Central Pacific which is to leave the main line at Winnemucca, Nevada.

The railroad situation in Colorado is a peculiar one at the present time. There is no competition anywhere and no prospect of any. Rates are the same over the three lines leading from the East.

A line 14 miles long, of the New York and Canada Railway, has just been completed from West Chazy, N. Y., to Rouse's Point, and will be used as the main line, the old line being used as a branch.

A large force are engaged in repairing the Little Rock, Mississippi River and Texas Railroad from Chicot to Medford, Ark., thirty miles of which was washed away at intervals by the last rise in the Mississippi.

A meeting of citizens interested in the proposed Herkimer and Newport Railroad (N. Y.) was held Sept. 6th and measures taken to organize a company. The length of the line is 12½ miles, and estimated cost $147,000.

Ground was broken at South Billerica, Mass., for the new 24-inch Billerica and Bedford Railroad, Wednesday, Sept. 6th. The "breaking" was conducted with great ceremony, ex-Gov. Talbot and others making speeches.

The Covington, Columbus & Black Hills Railway, 3' 6' gauge, leaves Covington, opposite Sioux City, Ia., running southward to Dakota City, and thence northwest along the Missouri river to Pouca, 30 miles. No further extension is expected this fall.

Col. J. W. Finney of the U. S. Engineers has been detailed to survey the Union and Central Pacific Railway between Omaha and Sacramento, it being alleged that the measurement of distances on which the U. S. bonds were issued to the companies were inaccurate.

The Kankakee and Gardner Railway, 28 miles in length, from Kankakee, on the Illinois Central, to Gardner, on the Chicago and Alton Railway, has a large force tracklaying, and will soon be completed; it will probably be worked by the Cincinnati, Lafayette and Chicago R'y Company.

A contract for 20 miles of the Washington, Cincinnati and St. Louis Railway, from Harrisonburg, Va., to North River Gap, has been let to J. W. M. Allemony of Harrisonburg. Contracts will soon be let for an additional 25 miles to Monterey in Highland County, Va. The eastern terminus of this road will probably be at Alexandria on the Potomac.

The proposed Pittsburgh and Lake Erie Railway, as located, follows the Ohio river to Beaver, then runs up the Big Beaver to Newcastle and thence up the Mahoning to Youngstown, where it will connect with the Atlantic and Great Western. The distance from Pittsburgh to Cleveland is 135 miles while by the present Cleveland & Pittsburgh Railway it is 150 miles.

Citizens along the line from Sterling to Byron, Ill., have accepted the proposition of Osterberg, on behalf of the St. Louis, Rock Island and Chicago Railroad Company, to build the extension between Sterling and Byron, and complete the same by November 30, 1876, for $100,000 and the right of way granted. Work has already been commenced, and the job will probably be completed by the date agreed upon.

Contractors' Intelligence.

Mr. John B. Benedict, contractor, broke ground at Avondale, near Cincinnati, on Aug. 31, for the Miami Valley Railway.

The contract for paving and grading Sedgwick street, Chicago, between North and Lincoln avenues, has been let to J. V. McAdam.

A petition, largely signed, was received Sept. 9th, by the Common Council of Oshkosh, to build a bridge across Fox river, from Light street to Oregon street.

The City of Louisville, Ky., invites proposals for 25 or 50 acres of land upon which to erect a new Work House. Architects, and others interested in building contracts will make a note thereof.

The aid secured for the grading of a railroad from Quincy to Beardstown gives those interested great encouragement. The subscriptions so far are liberal and the prospects are favorable for raising the entire sum needed to do the work.

The contract for the large cables of the Brooklyn bridge, which will amount to over $1,000,000, is exciting much interest in the wire manufacturing business. It is thought the trustees, at their next meeting will take some step toward making public the specifications.

Mr. Isaac S. Cassin, engineer, of Philadelphia, has the contract for constructing Water Works at Ashland, Pa. The supply will be by gravitation, and be brought a distance of five miles, under a head of 350 feet. The supply per day is estimated at 2,500,000 gallons. The work will be completed this year.

St Louis, Sept. 8—The Board of Indian Commissioners completed their labors here this evening, and most of them left for their homes to-night. They will go to New York where the proposals for clothing etc., will be received and contracts awarded. Contracts were awarded here to the following parties: For beef on the hoof, Thomas Lanijan, Arkansas; Mr. Rosenthal, Santa Fe. Mess pork, Armour & Co., Chicago; Castner & Penner, St. Paul; Joseph E. Podge, Sioux City. Bacon, W. E. Richardson & Co., St. Louis; Messrs. Armour & Co., Chicago. Corn, F. H. Davis, Omaha. Flour, C. E. Hodges, Sioux City; Castner & Penner, St. Paul; N. P. Clark, St. Louis; N. W. Wells, Schuyler, Neb.; J. G. M. Gunon, Seneca, Mo.; Newman, Harpwood & McLaughlin, Arkansas City; Wm. Speigberg, Santa Fe and Newman, St. Louis. Hard-bread, James Garneua & Co., St. Louis. Soap, Goodwin, Behr & Co., St. Louis. Transportation, Northern Pacific Railroad; D. J. McCann, Omaha; John H. Charles, Sioux City; M. Brunswick, Chicago; A. Staab, Pueblo, Col.; E. Neagle, Cheyenne; Ed. Felon, Leavenworth; J. H. Nichols, Cheyenne; C. Hecht, Cheyenne.

Institution of Civil Engineers.

The council of the Institution of Civil Engineers invite communications, of a complete and comprehensive character, on any of the subjects included in the following list, as well as on other analogous questions. For approved original communications the council will be prepared to award premiums, arising out of special funds bequeathed for that purpose.

1. On the flow of fluids, liquid and gaseous.
2. On portable apparatus for gauging the materials, and for the expeditious mixing of large quantities of Portland cement concrete.
3. On the value and strength of the different materials used for making concrete; with experiments on the proper proportions of the various ingredients, and of the water, whether salt or fresh, to produce the strongest mixture.
4. On the application of steam machinery for excavating, and the cost as compared with hand labor.
5. On stone-quarrying and stone-working machinery.
6. On the manufacture of cast and wrought iron and of steel of various qualities; on the effect of the admixture of foreign substances, and on the experimental tests by which the quality may be ascertained.
7. On the process of forging by steam hammers and other percussive machinery, and by the hydraulic press.
8. On the effects of pressure on cast steel and in the mould.
9. On the results of experience in the recent extended use of steel in mechanism and in works of construction.
10. On the alteration in the condition of metals caused by use or wear.
11. On the best mode of uniting steel and other metals employed in construction and in boiler work, and on the effect of the operations of punching, drilling and riveting on such metals.
12. On the construction of warehouses and other buildings for storing goods, with the special view of resisting fire, and on the relative merits of brickwork, iron, and timber for that object.
13. On the construction of street tramways, the best means of adapting them for the conveyance of passengers and goods, and of preventing injury and inconvenience to other carriages travelling on the same roads.
14. On modern methods of constructing the foundations of bridges.
15. On the design, generally, of iron bridges of very large span, for railway traffic.
16. On the comparative merits of European and American wrought iron railway bridges.
17. On canal locks, inclined planes, and other modes of overcoming differences of level on canals.
18. On dock gates and caissons, including a description of the requisite external and internal arrangements, with recent practical examples.
19. On percussive and other rock drills.
20. On the appliances and methods used for tunnel-driving, rock-boring and blasting, in this country and abroad, with details of the cost and of the results attained.
21. On railway rolling stock capacity in relation to the dead weight of the vehicles.
22. On the best mode of testing iron and steel for railways.
23. On the water supply of towns, including a description of the sources of supply, of the different modes of storing, collecting, and filtering water, of the various incidental works, of the distribution to the consumers, and of the general practical results.
24. On the constant service of water supply, with special reference to its introduction into the metropolis, in substitution for the intermittent system.
25. On the various modes of dealing with sewage, either for its disposal or its utilization.
26. A history of any fresh water channel, tidal river, or estuary,—accompanied by plans and longitudinal and cross sections of the same, at various periods, showing the alteration in its condition,—including notices of any works that may have been executed upon it, and of the effect of the works.
26. On the relative value of upland and of tidal waters in maintaining rivers, estuaries and harbors.
28. On the different systems of river and canal towage,
29. On improvements in the construction of furnaces and on combustion.
30. On the construction of steam boilers, adapted for very high pressures.
31. On the best practical use of steam in steam engines, and on the effects of the various modes of producing condensation.
32. On the results of experiments in steam jacketing.
33. On the modern construction of marine engines, having reference to economy of the working expenses, by superheating, surface condensation, high pressure, great expansion, etc.
34. On the construction of portable steam engines, or other motors, of very light weight, suitable for light boats, aerial machines, etc.; and on condensing with air.
35. On the relative cost of the conveyance of coal by rail and by steamer, and on the best mode of loading and unloading to diminsh breakage.
36. On the various descriptions of pumps employed for raising water or sewage, and their relative efficiency.
37. On the employment of wind or water as a motive power, their relative advantages and disadvantages compared with steam power, and the motors most suitable for utilizing them in the best manner.
38. On the use of gas as a motor.
39. On the best methods of removing grain in bulk from a ship to a warehouse, and on the various modes in which grain is stored in bulk.
40. On the manufacture of mineral oils, and the lamps best adapted for their consumption in dwellings and lighthouses.
41. On the "output" of coal in the United Kingdom, as compared with that of other countries, illustrated by statistics, plans, and diagrams showing where coal is produced, and where and how it is consumed.
42. On the sinking of, and machinery applied at, deep coal mines (in Saxony, for instance), with a notice of the modifications necessary in future coal mining operations suggested (or indicated) by the working of deep sinkings.
43. On the ventilation and working of railway tunnels of great length.
44. On compressed air as a motive power, particularly as applied to machinery in mines and to locomotives in tunnels, with some account of its application on the continent; and generally on the methods of transmitting force to distant points including details of the existing systems of rope transmission.
45. On the dressing of the ores of lead, copper, zinc, and tin, by any other process than that of water, and on the smelting of such ores, with details of the result and cost by different methods.

46. On the washing of small coal, and the manufacture of coke and artificial fuel.

47. On heavy and light wood working machinery.

48. On pneumatic telegraphs, and on pneumatic despatch tubes, designed with a view to economical working, and to the attainment of high speeds in long lengths of pipe.

49. On recent progress in telegraphy, including a notice of the theoretical and practical data on which that progress has been based; with some account of the improvements in the construction of land and sea lines and in the working instruments.

Water Works, Ancient and Modern.*

BY E. H. D'AVIGDOR.

(*Continued from page* 295.)

We now come to their mode of construction, and I will describe the different modes of work in a few words with the assistance of the sketches (Figs. 2 to 10), calling your attention to the principles on which they are based, namely, the Roman rule of thumb, and the extreme division of labor. The Romans knew how to get over difficulties better than any nation in the world. They managed to build under any circumstances whatever. If no stone was to be had, they used bricks; if the bricks were bad, they constructed of concrete; and the different guilds were so wonderfully clever in carrying out their respective work, that they were able to erect buildings of materials which no engineer of our day would pass. And although, of course, we have made immense strides in plan and design, our finest buildings are still far behind those of the Romans in nicety of detail.

It is a popular error to suppose that the Romans worked with ashlar only. On the contrary, they employed it only when it was more advantageous as compared with other materials, where great durability was required, or where the beauty of the building had to be considered. For instance, we find hewn stone in the constructions nearest Rome, in bridges of large span, in places where good quarries were at hand, and, finally, where cheapness of carriage, and the lightness of the stone itself did not increase the price of ashlar far beyond what other materials would have cost.

Roman masonry is especially remarkable for the accurate cutting and dressing of each separate stone. In ashlar, mortar was not generally used, because the joints fitted so closely that there was postively no room for it between them. Observe the *opus revinctum*, or keyed masonry (Fig. 4), in which each stone fitted into the other so accurately, that not a stone could be moved without destroying the wall. Mr., now Sir John, Hawkshaw applied a somewhat similar bond to the head of the Holyhead Breakwater, which is exposed to the furious gales of St. George's Channel. It must be admitted, however, that the Romans themselves only used this construction in very exceptional cases. They were generally content with laying fine large stones in horizontal courses, paying particular attention to the joints, and occasionally, at a later period, they secured the stones to each other by brass or iron dowels (see Fig. 3).

Their rubble work was executed in several different ways, as shown in the sketches (Figs. 5 to 10). The Romans were very fond of using ashlar for the quoins and faces, and were particularly given to *opus vecticulatum*, or network, which consisted of small square stones hewn on the face, set on edge, and having a rough tail (Figs. 5 and 6). These stones were enclosed by a frame of horizontally coursed ashlar or bricks, and the filling in consisted of small stones laid in thick mortar beds. This network presented an extremely graceful appearance, but had no great cohesion, as the face stones had no satisfactory bed and only a middling bond; it had therefore to be constructed of very large dimensions. Their ordinary rubble-work (*opus incertum*) was very similar (see Fig. 7) to ours, but they used much larger quantities of mortar in the backing than would be admitted now-a-days.

The Roman brick buildings are more interesting. Their bricks were in fact *tiles* from 6 in. to 12 in. square, and 1 in. to 2 in. thick. They hardly ever used the same sized bricks throughout a building; for they placed square bricks (or tiles) at the quoins, and triangular ones in the faces, and the joints were so carefully broken that no example has yet been found where one joint is over another. After each course the backing was filled up with mortar, and, as M. Choisy has proved by his recent investigations, small stones were laid in this mortar bed by hand, or possibly sometimes set with a hammer, but in house-building or in the construction of free walls, they were never rammed. In retaining walls, on the contrary, quantities of small rough stones were thrown into the mortar bed behind the face and then rammed down; during this process the face was kept vertical by wooden struts, and after it the next course of bricks was laid, and the process recommenced.

It is certainly wonderful that these buildings lasted so long, for the materials and the mode of using them would now both be equally condemned. And I repeat, it is only owing to the perfect work performed by each separate man, and to the enormous thickness of the brickwork, that an aqueduct constructed in this manner could have lasted 2000 years.

The reason of certain peculiarities in the construction of the Roman arches has long been a mystery, and these peculiarities can only be explained by the very great scarcity of timber in Rome even in very early times owing to the wasteful destruction of the Italian forests. The Romans, therefore, were constantly trying to save timber, and they did so by economizing their centering and building in several peculiar ways. In the case of large arches of ashlar masonry the first three or four voussoirs were laid on each pier or abutment without any centering at all. As soon as the inclination of the joints attained an angle of 18 deg. or 20 deg., a couple of large voussoirs were laid on each side having considerable projections or tails inside the intrados. The centering was then placed on these projections, and the builders were thus able to save a very considerable length of tie beam, and nearly half the length of the struts, and could therefore largely reduce all the scantlings of the timber (see Fig. 11). This scarcity of timber explains another mode of construction, in which the arch was executed in a succession of narrow bands parallel to the centre line of the road or aqueduct it carried. These bands or narrow arches were carried up one after another on the same centering, and the space between them was covered over with slabs or tiles (see Fig. 13). A third method was the following: The centering of very light scantling having been set up, it was completely covered by a mortar bed in which they laid one course of flat tiles. When this ceiling of tiles was well set, the arch itself was begun by several courses of tiles used as voussoirs, and therefore set on edge on the former course. When the angle formed by these courses began to differ considerably from the radius of the circle, a block of concrete was run in with radiating faces, and then tiles again as before, the circle being finally keyed by a block of concrete (see Fig. 12). Of course arches constructed in this manner had to be very heavy, otherwise the concrete would have offered insufficient resistance, and had they not used the layer of flat tiles, a very strong centering would have been required. But this layer gave the light centering the necessary support by relieving it of a great portion of the weight, and enabled the Romans to construct arches of large span with very poor materials and very light timber scantlings. The intrados of the arches presented a very neat appearance with its smooth mortar bed.

The above-mentioned use of bands in the construction of arches was largely applied to the cross vaulting of reservoirs, temples, cellars, etc., and it is a matter for reflection whether the Gothic groins of a later period do not owe their origin to the Roman band arching, in which the spandrils and vaults were filled in with lighter material resting on them.

In the case of very large spans (40 ft. to 80 ft.) a saving of timber was effected by executing the arch in a series of concentric rings, so that the innermost ring became the centering for the second one, which was only commenced when the former was perfectly set (see Fig. 14). Although, therefore, these were not bonded together at all, but, on the contrary, executed successfully at intervals of time, the accuracy of the work and the dressing of the voussoirs are such that no cracks and no settling whatever are to be discovered in them. Nor could such a settling escape the eye, as the Romans always built in arcs of circles. The thickness of the voussoirs was very considerable. Those of the Marcia Aqueduct, whose span is 4.72 m. (about 15 ft.) are 0.75 m. (about 2 ft. 6 in.) thick. As compared with modern dimensions this is enormous. Thus the Liesing Aqueduct in the Vienna Water Works has brick arches of 13.27 m. (about 42 ft.) span, while their thickness is only 0.92 (3 ft.), and the 36 ft. span consists of five rings of half bricks, equal to 2½ ft., therefore only the same thickness as a Roman arch of two-fifths the span.

Although the above description is rather lengthy, it would still be incomplete if I did not mention the Roman mortar, which played so prominent a part in all their constructions of brick, rubble, and concrete. The material now called Roman cement was, I need hardly say, quite unknown to the Romans, nor did they use natural hydraulic limes or artificial Portland cement. Their mortar was composed as follows: One part slaked (rich) lime; one part brickdust (known in India as Toorkee, and used there for the same purpose); and two parts clean river sand. If quarry or pit sand was to be had (which they preferred) three parts of the latter was substituted. The care used in choosing and storing the sand, lime, and brickdust far exceeded the precautions now taken even by the strictest resident engineer. They excavated immense pits, lined them with masonry, and erected a roof, or even a vault, over them. Here the sand, after being screened, was secured from the influence of the weather. The lime was specified to be slaked a year before using. It was spread out in large sheds, and the slaking was carried on by the influence of the air almost without any admixture of water. When very hydraulic mortar was required, the Romans substituted Puzzolana for the brickdust. This was carefully screened and kept dry; in short, the mortar-makers of ancient Rome, who never did anything all their lives but mix mortar, went through their work with such care and accuracy that we should now require a chemical laboratory to do as well.

Puzzolana, well known in England, renders mortars made with rich lime very hydraulic. The Sautorin earth of the Adriatic coast and the Trass of the Rhine are other volcanic products possessing similar qualities, but in a minor degree. In fact, Puzzolana has only recently been driven out of the field of English construction by the manufacture of artificial Portland cement.

The inner lining of aqueducts, which had of course to be impermeable, was carried out in a similar way. The canal, drain, or reservoir was first covered with a coat of mortar made up in the proportions indicated above with coarse sand; the second coat contained screened Puzzolana and fine sand; while the last was laid on with a fine liquid grout, the whole then being covered by a singular mixture of linseed oil, lime slaked in red wine, tar, and wax. This was well rubbed in till the whole surface became as smooth as marble. It does not appear that the Romans supposed that this curious compound would produce a permanently hydraulic surface; all they wanted was to give their last coat of mortar time to set before the water got at it. Pliny adds pounded figs to the above prescription, and it appears from him and Frontinus that working and polishing the inner face was a job requiring great attention and some considerable time.

The concrete, which I have mentioned several times, and of which, in fact, many lengths of Roman aqueducts were entirely constructed, was made as follows: First a mortar bed was laid, the mortar itself being composed according to the circumstances as described above. Then the broken stone was either thrown in—as in the case of retaining walls—or placed by hand for arches, housebuilding, etc. But it does not appear that in any case the concrete was regularly made upon a platform, and each stone covered with a cementing material, by the process of turning over and mixing, as is now the case with us; the mortar bed was invariably laid *into* the work first, and the stone thrown or placed in it afterwards. Thus the quantity of mortar in proportion to stone used was greater than in modern works.

In the above description I have purposely omitted many interesting details of the Roman art of building, and have confined myself to a general view of their modes of construction as applied in aqueducts, reservoirs, and cisterns. I will next proceed to a brief review of the works themselves, which will, however, occupy so much less space, as I have already sufficiently indicated the materials employed in them.

(*To be continued.*)

* A course of papers delivered at the Austrian Institution of Engineers and Architects, December, 1875, and January, 1876.

JETTY REFLECTIONS.

In our issue of Aug. 19, we printed some most interesting conclusions of G. K. Gilbert, Geologist, to the Wheeler Expedition, in regard to erosion of river beds, and the transportation of detritus. Let us formulate some of these conclusions, which bear on silt bearing rivers. Those, to whom they may not appear obvious, we refer to the article in that issue.

1° The total energy of a stream is equal to its mass multiplied by the perpendicular distance through which it descends.

2° This energy is consumed in friction on the stream bed and in transportation of detritus. [Friction produces internal motion of the water to which its suspending power is due.]

3° Suspended matter is a draught on the energy of the stream equal to its weight (in water) multiplied by the vertical distance it would sink during the time it is suspended.

4° A greater per cent of the energy of a stream can be utilized by fine detritus than by coarse [Velocity will be less with maximum load of fine detritus than with coarse.]

5° The capacity of a stream for transportation, is enlarged in more than simple ratio by increase of volume, and in more than simple ratio by increase of declivity.

6° The velocity of a stream depends on volume and declivity and (inversely) on load.

7° A stream loaded to its full capacity does not corrade; partially loaded it corrades; overloaded it precipitates.

A careful consideration of these condensations and a full realization of their import leads to most interesting deductions in regard to the question under solution at South Pass.

The Mississippi River from New Orleans to its mouth for all practical purposes may be considered as completely charged with detritus, as it has exhibited no tendency to corrade its banks or deviate from the course it has pursued for the past century. Its cross-section has undoubtedly increased somewhat during the time since the floods of the river have been largely confined by levees, but on the whole, below New Orleans, more particularly for the lower half of this section, the river may be considered as in a state of equilibrium, neither depositing sediment or eroding banks.

When we reach the passes we find they are not marked with the same stability as the section just alluded to. One pass will continue to be the main pass of the river until the formation of islands at its mouth and the subdivisions of its waters, its more rapid advance out to sea from receiving the major bulk of sediment, formation of mud lumps, etc., all increasing its resistance, disturbs the delicate equilibrium existing between the volume, declivity, cross-section, etc., of the several passes, and some shorter pass commences to enlarge and becomes the main pass to, in turn, be supplanted by some other pass when the original conditions are reproduced. It is a case of unstable equilibrium in which the forces are constantly adjusting themselves to the work along the line of least resistance. However delicately poised may be the forces the changes are accomplished so slowly, that we say the equilibrium among the forces and resistances of the passes as a whole is perfect.

In the case of an individual pass, it can at no time be considered as having a permanent regimen. It is either enlarging or diminishing or in that delicate poise which may mark the change from one state to the other and give a practically constant regimen for many years. South Pass was probably in this condition; having reached its minimum cross-section and volume, and having the maximum surface slope or the shortest length, it was prepared to answer to the increased duty to be imposed upon it when S. W. Pass had pushed itself so far out to sea, that increased resistances would turn the balances and throw it into a state of decay. So no pass is liable to entirely silt up or decay and each pass must in time become alternately the main outlet.

Suppose the jetties to have been placed in S. W. Pass. The additional resistance imposed on the pass for the time being would have turned the scale, say in favor of South Pass, and S. W. Pass would, owing to increased length have fallen rapidly into a permanent state of decay, to in time become a mere bayou. We could conceive, looking ahead not more than the twenty years for which Capt. Eads was to maintain the works, that they might become a most inglorious failure, and the jetty system damned for all time. So we deem it a most wise blunder that the jetties were located on the shortest, although for the time being the smallest pass, to the sea. Once the pass is scoured out to its normal cross-section its permanence is assured for many a decade and works will rather be required to prevent its assuming unmanageable dimensions. At some distant day the lengthening of this pass will cause its abandonment for some other.

The above considerations show the remarkable equipoise, the delicate adjustment existing in the relation of the passes, and presents a problem which must be attacked with extreme caution and a full realization of the most delicate conditions involved. No pint-measure hydraulics is adequate. Let us analyze the results likely to follow the works established at South Pass. Consider the stream as flowing in a bed of its own deposits and to be fully charged.

The regimen of South Pass for any short period of time may be considered as permanent. (If not we will so consider it for the time being.) Suppose we carry work across the bar which shall diminish the cross-section at the bar to one-fourth, more or less, of the normal section in the pass above.

Then, 1st, to carry the same volume of water across the bar the velocity must be increased four times, more or less, requiring an extra head exactly equivalent to this increased velocity; 2d, friction diminishes with wetted perimeter but increases as square of velocity, hence an extra head will be required to overcome the increase of friction in the contracted stream; 3d, the increased velocity will throw the stream into a state of undercharge and it will corrade its bed and take up an additional load. This will impose an extra duty on the stream requiring an extra head. This last will probably be the heaviest draught on the energy of the stream. Thus for three reasons we see that an increased head will be required to maintain the volume across the bar and these will continue, of course with diminishing force, until the channel across the bar is of the same cross-section as the normal section of the pass. But as the passes are all connected, extra head cannot be obtained except at the expense of the volume and velocity of the water in the pass itself.

This diminution of volume and velocity, however slight, must cause deposition to take place, thus diminishing the cross-section of the pass itself, adding a fourth element to decrease the volume of water in South Pass. However slight these several causes may be they are cumulative, increasing rapidly in a multiple ratio. This is not all, however; the volume excluded from S. Pass by these four causes is turned into the other passes, whose cross-sections, not being hampered, are permanently enlarged to this increased duty and S. Pass of itself cannot regain it. The result is a compromise, the channel between the jetties being eroded and the pass above silting up, until there exists a uniform but diminished cross-section throughout the pass to the sea. With this diminished cross-section the equilibrium is destroyed, the proper relation between volume slope and cross-section no longer exists, and the pass is bound to silt up and become a bayou.

A little more than half way up the pass, Bayou Grande leads off considerably more than one-fourth its volume. The cross-section of the Pass below this point is about three-fifths of that above. The slope below is also greater, as is to be expected. This bayou is now closed. What must be the effect? The jetty advocates assume that its entire volume will be turned into South Pass, and that the cross-section below (15,000 sq. ft.) will be increased to that above (25,000 sq. ft.). It will require an extra head to force this large volume through the smaller cross-section, due 1st, to extra velocity; 2d, to extra friction, and 3d, to extra duty in excavating, and these will obtain until the section is normal with that above. The section above will silt up and finally a compromise will be effected by which a less volume on the whole, will enter S. Pass and a greater volume will pass out between the jetties. The other passes as before will answer to their increased duty and on the whole water is permanently taken from S. Pass. It is impossible to tell how much compensation there may be in the increased volume on a greater slope below Bayou Grande; but without going into a fine analysis of this point, we would say that this bayou leaves the pass too near its head, too great a task being imposed on the water of the pass. If it left the pass near its mouth, more favorable results might be anticipated from closing it. We believe that less water would flow into South Pass.

So the conclusion is that the works at present constructed have caused a less volume to flow through S. Pass, the cross-section of the pass is diminished and the whole pass is thrown into a state of permanent decay, to in time, nothing farther being done, become a simple bayou. These conclusions are deduced from purely *a priori* grounds.

Again suppose the jetties to be carried suddenly out to sea and the channel between them in some way to be excavated immediately to the normal section of the pass. Then, undoubtedly, the resistance will be less than before; a greater volume immediately sets through the pass, the equilibrium is disturbed in an opposite direction and the pass will continue to increase in dimensions and unless works are erected to restrict it, it will ultimately become the main pass. So every consideration should have pushed the jetties to the earliest possible completion, and no expense should have been spared to aid and supplement the current in removing the bar quickly.

In the mean time the pass would of course contract, but if the bar was quickly enough removed, the diminished resistance might be sufficient to counteract the effect of the silting, and the tide turned the other way. When that was accomplished and the bar entirely cleared away, the pass could the better stand the strain from the closure of Bayou Grande, which ultimately, in that case, would improve the channel over the bar and the pass itself.

We of course think these conclusions well taken and naturally are inclined, so far as we are inclined at all, to accept the reports that the volume of water flowing through S. Pass has permanently diminished and the Pass itself silting up or in a state of decay, Reports to the contrary, apparently as well authenticated, merely causes us to suspend judgement, until we may know for a certainty, the truth.

Therefore, for reasons that we have stated, so far as supporting the theories on which the jetties were based, we think they are a failure. So far as accomplishing the results to be expected in a permanent deep channel to the sea, we think again, they have already failed. Of course we expect a greater depth yet across the bar, but we also expect greater silting above until the compromise is affected, which in the absence of auxiliary works, we are persuaded will result in failure.

The South Pass jetty works have tailed, and we think Capt. Eads himself realizes it more keenly than any other. We have watched the operations for several months, now, expecting to see done what is being done, and it is with a keen zest that we appreciate the fertility of resource of Capt. Eads and the energy with which works are now being prosecuted to push forces back over the equilibrium point and at last to crown all with success. It can succeed yet, but how? Water must be again brought back into South Pass. Works building ostensibly to remove a shoal at the head of the pass are really to get more water. It must be had and these long dams thrown out across S. W. Pass and Pass a Loutre are for that purpose. But it must be done quickly. The river waits on no man's dalliance. As the wing dams are thrown out the mighty river enlarges its channel past them and the only hope is to push the wing dams faster than the river can excavate its channel. For only a short time will this be necessary, for the increased supply turned into S. Pass, will soon accomplish its work and the balance once turned, it can be left to itself to do the rest. In less than six months the deep channel to the sea will be a succes or a failure. If a failure we can throw a dyke across the head of South Pass and make of it a magnificent canal. If a success we will shake the energetic Captain by the hand and hope he will not mar his well deserved fame, by attributing the success of his enterprise to false principles. He can then, if not now, afford to acknowledge the errors of theory, which our humble judgment would attribute to him.

GEORGE SMITH, the great Assyrian Explorer and scholar, is dead. To Rawlinson and Layard great credit is due for their early discoveries and translations of cuneiform inscriptions. But to George Smith's studies

of the Assyrian tablets in the British Museum, and his subsequent discoveries on the banks of the Tigris, is due the unearthing of many legends which illustrate the early religious customs of a primitive civilization, and which brush away many cobwebs that had gathered about the writings of Moses and the prophets. All archæologists and philologists will deplore the great misfortune of his early death, for, although his labors have borne much fruit, the starchy grains had not yet assumed the mellowing richness of the ripening.

HELL GATE is now being rapidly charged with explosives, 50,000 lbs. of which will be used, made up into cartridges and placed in 7000 holes. The explosion will take place as soon as the charging is completed, which may be by Sunday and possibly not until the middle of next week. The newspapers are taking great interest in the affair and seem inclined to doubt Gen. Norton's assertion that little or no damage will be done. Undoubtedly if the 50,000 lbs. were to be exploded in one spot, with little or no resistance to overcome, the destruction would be wide spread and incalculable But distributed as it is into numerous small charges carefully apportioned to the work required of it no danger is to be apprehended. The blasting of rock by large mines has now been so closely studied, and the nature of the explosions are so well known, that it would be the veriest stupidity that should cause extensive damage at Hell Gate. Possibly in a few cases the strength of the rock may be miscalculated and local disruption take place. But on the whole no damage is to be expected.

FROM time to time rumors fly through Great Britain that the Parliament buildings are settling in a most dangerous manner. Situated on the banks of the Thames, among the Westminster sands, in probably the most unfavorable site that could have been found, the foundations were so well designed and laid that very little settlement has taken place. The Victoria tower of 200,000 tons was carried through the sand to the Thames silt, probably one of the best of foundations. This was covered eleven feet thick with concrete on which the tower was built and has stood for forty years without settlement. Two settlements have, however, taken place, one very slight, in the wing of the building fronting Abingdon street and Palace yard, which long ago ceased; and the other in the S. W. river front where two quite ugly but not dangerous cracks exist. The settlement, however, is believed to have ceased. All the exterior work is of limestone which is quite absorbent of moisture. As a consequence the delicate carvings and corbels are apt to suffer, and workmen are constantly engaged in replacing injured stone by others selected for their hardness. No finely carved stone, except granite, will long resist the corrosive action of the London atmosphere, though in smooth surfaces the stones of the palace show no signs of decay.

SPRINGFIELD, Ill., Sept. 12. 1876.

Editor Engineering News.—Dear sir: Enclosed find P. O. order for five dollars, a small donation to the engineering exhibit at Philadelphia, a small amount to be sure, but is all I feel able to contribute.

I remain very respectfully, W. D. CLARK, City En.

At the last meeting of the Civil Engineers' Club of the Northwest, reference was made by President Chesbrough to the Engineering Exhibit at Philadelphia, and the necessity for the raising of $2.000 more by the profession to defray expenses. In response to this indirect appeal to the profession at large we are pleased to receive the above as the first donation to the fund. We consider the contribution of Mr. Clark a very liberal one and commend his generous example to the Engineers, Architects and Contractors of the country. Every person who is interested pecuniarily in works of construction is benefitted by the Philadelphia exhibit, and is as much entitled to contribute to the payment of the expenses thereof as any Society, or member thereof, may be.

The time has come when engineers and architects must join hands in advancing the standard of their respective professions, and asserting their claims to a status in society co-incident with their usefulness and merits. The exhibit at Philadelphia surpasses anything of the kind that has ever been made and its influence on foreign and American engineers cannot fail to be beneficial. The total amount of the indebtedness incurred by the exhibition is not large and a small amount from each engineer, architect and contractor to whom this notice may come will soon clear it off. It is to be hoped that an immediate response will be made and contributions sent in promptly to the Finance Committee of the American Society of Civil Engineers, No. 4, 23rd street, New York City.

THE PATENT ENGINEER.

We are always sorry to be misconstrued and it affords us particular pain to have our fine sarcasms interpreted into personal assaults on men's professional calibre. To turn our paper from its legitimate function, and use it for the purpose of grinding anyone's axe or to impugn anyone's character as an engineer is wholly foreign to its objects. Such imputations are rare to us and when made we shall always endeavor to return them with interest.

When any man, professional or otherwise, enters the service of the public, his acts and works so far as they concern said public, are public property and subject to public criticism. If he be an inventor, then his invention, so far as it is intended for public use is also open to criticism. In either case it is the duty of the professional paper to commend what is good, condemn what is bad, and criticise justly when criticism may be necessary, and so protect the public in all possible ways. In this discharge of its duties it may occasionally "tread on some one's toes," and while the man owning the toes may cry out, he certainly is not the one to judge of the justness of the strictures.

In our article of Sept. 9, in which we endeavored to express our views on a certain phase of the patent business, as concerning engineers, and in which we mentioned some inventions in illustration of our point, we are sorry to learn that one of the inventors, has felt aggrieved and construes the article to be wholly aimed at him. If the gentleman has laid himself liable, either by professional act or through his invention, we shall most certainly exercise our right to indulge in such criticism as to us may seem just, and this without reference to his status.

In this patent business as concerns engineers, we lay down two broad propositions.

I. No engineer when employed and paid for his services on a given piece of work, should allow himself to patent designs or devices which he may adopt in the execution of said works.

II. Engineers should not be hampered by "patented ideas" the more especially in those features of the work which vary with condition and circumstance and in which the engineer's abilities are chiefly required.

Now there is no law to govern either of these cases and the many modifications of them which often occur, except the unwritten law of the profession, that high professional sense of duty to which, more than in any other profession probably, its remarkable *esprit* is due.

Engineers and architects usually design their work entirely without reference to patent rights except in some minor and often recurring detail. They simply ignore the patentee and his invention which is usually the best way and one that can ordinarily be followed in safety. The profession is too old not to have most of the "original ideas," the duplicated of those in times past.

No architect would think of patenting a facade or a court house; neither would Capt. Eads think of patenting the jetty system, supposing himself the original inventor.

We shall unhesitatingly condemn every engineer who is guilty of this breach of professional custom and duty and shall very much question his right to bear a title which should indicate more than mere constructive ability.

HOLYHEAD NEW HARBOR.*

There are not many places in this country at which the construction of expensive harbor works is justified. Having practically an unlimited coast line, in many places deeply indented with bays and estuaries, with comparative moderate tides, with no jealous and intractable foreign governments to hedge us in and dispute with us commercial supremacy on this continent, the great centres of commerce have uniformly originated and grown up about our great natural harbors, in those recesses of the coast to which the interior was accessible either from geographical position or through great rivers and their valleys, through the natural channels and outlets of domestic productions. Such is the history of Portland, Boston, New York, Philadelphia, Baltimore and other ports of the Chesapeake, Charleston, Savannah, New Orleans, Galveston and San Francisco. Such will be the history of San Diego in Southern California, Portland in Oregon, and some point on Puget Sound in Washington Territory. Such will be the history of other points on our Atlantic and Gulf coasts as the necessities of trade or a higher and farther development of the interior shall warrant them. Congressmen may attempt through a mistaken policy to alter or reverse natural laws by distributing the appropriation for rivers and harbors pro rata, according to population, among the several states. But such distributing the appropriation of money for the improvement of creek mouths or the excavation of coast lines where natural advantages do not exist, is an unwarranted waste, and worse than useless, in subtracting so much from our commercial ports. Trade does not alter its channels for the mere beckoning, even if backed by government subsidy.

In European countries this is quite different. Jealous nations with comparatively limited coast lines, in many cases with few or no excellent harbors, are obliged to construct them, either in self-defence as a military necessity, or for the purpose of maintaining their relative influence in the channels of trade. In an insular country like Great Britain, with railways running to the headlands, which bound the shores of narrow straits, as at St. George's Channel on entering the Irish sea, or at Dover straits separating England from the continent, harbors are required for steam ferries. Again, in nations which were established and built up before ocean commerce might be said to have its being, large cities were founded on rivers or water channels it is true, accommodating the coasting and interior trade in vessels of small tonnage; but such harbors were inadequate to the commerce of to-day, and vast artificial constructions have been necessitated to bring such cities into the life-giving current without which they would shrivel and dwindle away. Such are the histories of London, Liverpool, Glasgow, Trieste, Brindisi, the ports of Holland and the Baltic ports of Prussia; Plymouth on the southern coast of England, where foreign steamship lines touch, is another example; and Holyhead in Wales, the terminus of the Irish packet service for Dublin, and Dover and Calais, (to be constructed) are examples of foreign harbors. Occasionally artificial harbors have been made on exposed coasts, as harbors of refuge. Such, partially, is the purpose of Holyhead harbor and the design of Dover harbor, and also others projected on the English shore of the German ocean.

A consideration of these facts, suggested by the paper mentioned at the head of this article, has led us away from the immediate subject on which we intended to write. The paper before us although of interest for its description of the works themselves is of greater value for its information on large blasts, blasting operations being carried on at Holyhead probably on a more extensive scale than in any works yet constructed. A short description of the harbor itself, and the causes which led to its construction, will be of interest.

Between 1835 ond 1837 the attention of the English government was directed to the importance of providing improved harbor accommodations for the packet service between England and Ireland. Holyhead on Holy island, oft the extreme northwest point of Anglesea, north of Wales, was, from its geographical position, the nearest point to Dublin, 64 miles. As the bridging of Menai straits for railroad purposes was then considered doubtful, Porthdynllaen and even Liverpool, were advocated in lieu of Holyhead. In the meantime the Chester and Holyhead railway had erected the Conway tube and later, the Menai straits bridge itself, both masterpieces and monuments of the early history of iron bridge construction. This determined Holyhead as the port for the packet service, and in the construction of the harbor works it was deemed best to make it of sufficient capacity for a harbor of refuge. This proved to be a wise de-

* A paper read before the Institution of Civil Engineers by Harrison Hayter, C. E., London, Eng.

cision, and before the works were completed it was used so much for refuge that the design was altered and enlarged giving treble the harbor capacity originally intended. The present harbor gives 667 acres of sheltered roadstead in which, on the average, 3500 vessels take refuge during the year.

The work was authorized in 1847 but not seriously commenced until 1850. Originally a breakwater, consisting of a rubble mound with a superstructure of masonry, was designed to run nearly due east a distance of 5,360 ft. enclosing an area of 267 acres. Subsequently 2500 ft. more extending in a N. E. direction was added sheltering a farther area of 400 acres, making a total length of breakwater of 7,860 ft. The rubble mound or "pierre perdue" is of great size; the average depth of water at low-water spring tides being 40 ft., the greatest, 55 ft., the variation of ordinary spring tides being 17 ft., and if equinoctial spring tides, 20 ft. The inclination of the fore shore, or slope from low water, is generally about 12 to 1 from high water at the superstructure outward to 1 or 2 ft. below low water, and about 2 to 1 from that point to the bottom. On the harbor side the slope is about 1¼ to 1. At low water the mound is nowhere less than 250 ft. wide, and in 50 ft. of water is about 450 ft. wide at the base. It contains about 7,000,000 tons of stone or 3,500,000 cu. yds. in quarry, or about 5,200,000 cu. yds. in place. This stone was dumped from five lines of railway carried on a wooden platform 150 ft. wide and 20 ft. above high water. The ridges of stone were kept higher under the three outer lines, and the storms washed the stones down and compacted the mound until it assumed the general dimensions given. The superstructure is placed as nearly as possible to the harbor side of the mound and consists of a wall of massive masonry, commencing at low water and extending, including parapet, on the seaward side to 25½ ft. above high water. On the harbor side a lighter wall was carried to 10 ft. above high water, and the space between the two walls was filled in with suitable material.

The total outside width of the superstructure is about 57 ft.; 4 ft. width of parapet, at 25½ ft. hight; 13 ft. of promenade at 21¾ ft. hight, and 40 ft. of terrace or quay at 10 ft. hight. The end of the pier is protected by a pier head 150x50 ft. founded at 20 ft. below low water, surmounted by a lighthouse 70 ft. from high water to the focal plane. In addition to the breakwater a beaching ground containing some 300,000 tons of quarry debris was constructed. The total cost of the breakwater and works connected therewith, including land, was about £1,285,000, or about 1,632.10 s. per lineal foot. The superstructure cost £36 per lineal foot. The stone were deposited for 2 s. 3 d. a ton for the first portion, and 2 s. 7 d. for the last 2,500 ft. Before operations commenced 2½ miles of railway were constructed, the money expended on all preliminary work amounting to £92,000. The rubble mound was essentially completed in 1863, a period of 14¼ years, and the superstructure is now about completed, making a total time of more than 25 years since the works were inaugurated. The breakwater was designed by the late Mr. Rendel and afterwards in charge of the author and Sir John Hawkshaw.

In the discussion of Mr. Hayter's paper many criticisms were made on the altered design of the breakwater and there was much difference of opinion on the cross-section of the breakwater itself. Many of the members thought if it were constructed anew the cross-section adopted would be quite different. The foreshore was rapidly being reduced to the condition of shingle and bowlders, and appeared to be travelling toward the head. Allusions were also made to Plymouth, Cherbourg, Portland, Wick, Kingston and other breakwaters.

Probably one of the largest blasts ever made was that of the Round Down Cliff, Dover, to facilitate the construction of the South Eastern railway. The mass of chalk to be removed was 360 ft. long, 380 ft. deep, and 80 ft. wide. A gallery was driven near the proposed rail level and the charge of 18,500 lbs. of powder placed in three chambers, the amount of powder required being calculated by Sir John Burgoyne's rule, viz., charge in lbs. equal to 1-32 cube of line of least resistance in feet. The product of this mine was 400,000 cu. yds. of chalk or about 700,000 tons, over 38 tons per pound of powder. In the largest mine at Holyhead, 130,000 tons of hard quartz rock, was removed by 21,000 lbs. of powder, or over 6 tons per lb. [Long tons of 2,240 lbs., are meant.] At Dover Cliff little more was required than to lift the rock from its place. At the Holyhead quarries, about a mile from the root of the breakwater, the rock was exceedingly tough and hard, admirably adapted for the purpose in view.

About 1,000 mines were fired. They might be divided into two classes; those with vertical joints on all sides, which were always carefully sought out and utilized in designing the mine, and "rooters-out," mines situated often at intervening angles with no joints, or a joint on one side only. The vertical face was of varying hight, often over a hundred feet. Shafts were at first sunk from the surface, but afterwards on account of danger from falling rocks and water, headings were carried in from the face of the quarry, two or more right angle bends being made so as to prevent the tamping from blowing out, an accident of this kind in the early part of the work resulting in the death of Captain Hutchinson, R. E., of Dover Cliff fame. When the heading had been carried into the joint or near to it, galleries were carried each way along the joint, or parallel to it, and from these galleries chambers disposed according to the plan of the joints, were carried a few feet toward the face of the rock. These chambers were pierced some three feet below the bottom of the quarry, and even then the quarry floor had to be leveled by small shots.

One mine which may be taken as a type of the joint mines, had a hight of face of 110 ft., length, 140 ft., length of heading, 35 ft., of gallery, 89 ft., with four chambers running toward the face of the rock. No. 1, was 12½ ft. long, line of resistance 23½ ft., charge 4,500 lbs.; No. 2, was 12 ft. long, line of resistance 24 ft., charge 4,000 lbs.; No. 4, was 9 ft. long, line of resistance 25 ft., charge 3,000 lbs.; No. 4, was 2½ ft. long, line of resistance 18 ft., charge 1500 lbs. Total charge 13,000 lbs.; produce 60,000 tons or nearly 5 tons per pound.

In the case of a "rooter-out" with a joint on side only, 44 ft. hight of face, line of resistance 21 ft., one chamber, a charge of 900 lbs. brought down 2,000 tons or 2¼ tons per pound. On the average 4 tons of rock were removed by one pound of powder. The charges varied from 600 to 21,000 lbs. In the mines giving a small product per lb. of powder, the rock usually flew about considerably, but in the large and more favorable blasts, the rock usually came down with slight disturbance; in a 120,000 ton mine, "a goat grazing on the top of the mass to be dislodged, came down with mass unhurt."

At the commencement of the work ordinary blasting powder was used, but after numerous experiments cannon powder was found the best, over 1,000 tons having been used on the work. Its strength was tested by the power of one ounce to throw a 68 lb. ball from a mortar at 45°, to a distance of 180 ft.

Owing to the varying hight of face and other conditions, it was not possible to adopt any rigid rule for the amount of powder required for a blast. This was governed somewhat by the quantity assumed to be removed by the blast. Sir John Burgoyne's rule was not found sufficient. The following approximate rules gives the result of experience at Holyhead. For ordinary shafts, charge in lbs. =1-15 to 1-20 of cube of line of least resistance in feet. For ordinary headings, 1-12, and for "rooter-out," 1-10.

In tamping the headings the powder was often built in for a few feet with a dry rubble wall, and the remainder of the galleries rammed with clay. The shafts were more readily tamped with quarry debris, stones, and clay, thrown in and rammed. Occasionally a space was left around the charge but this was believed to be of little use. Experiments, as recommended by Sir John Burgoyne, were made, such as mixing sawdust or other foreign matters with the powder, to allow for the expansion of gasses, but such recommendations have been proved by experience, fallacious.

The cost of quarrying the rock, including driving, powder and sundries 4½ d. (9 cts.) per ton, and the cost of filling into wagons, including blasting the large stones, was about the same. These rates were those at the maximum output of about 26,000 tons per week. This would make the cost of quarrying and loading into cars ready for moving away about 18 cts. per ton, our currency, or 36 cts. per cu. yd., which, considering the unusual character of the rock, is remarkably cheap, illustrating in a forcible manner, the economy of large blasts. We believe the largest blast ever made in this country was in clearing the site for a fort at Golden Gate, the entrance to San Francisco Bay. However we have not the details at hand. The explosion to take place shortly at Hell Gate will be the greatest yet made and will be doubly interesting in that it has no predecessor of a similar character.

NOTES.

Canada stands fourth on the list of the merchant navies of the world.

All the rivers of Maine are reported as very low this season, lower in fact, than for a long series of years.

Road steamers are allowed to traverse certain portions of Glasgow, and there are now seven of them employed by iron founders, boiler makers, etc.

High water and driftwood have completed the destruction of the St. Louis and Keokuk Railroad across the Des Moines River near Keokuk, Iowa.

The French minister of public works has given orders for the construction of the great refracting telescope, 17 metres long (53 feet), to cost 210,000 francs. Two years will be required for the work.

The area of "London according to act of Parliament" comprises 78,080 statute acres, equal to 115 square miles. In it there are nearly half a million of inhabited houses and 1,500 miles of streets and roads.

An astronomer, while observing the sun, noticed that birds frequently passed the disc or near it. They were several miles high, and entirely invisible to the naked eye. It is suggested that the use of the telescope may develop new fact in the migration of birds.

The Sutro Tunnel has struck 40 inches of water in its headings, now over 14,000 feet from the mouth. This is thought to be indicative of a vein not far off. As is well known there are two large outcrops on the line of the tunnel, before the Comstock itself is reached.

The man known of all students and educators, Professor Charles Davies, the great mathematician, is no more. He died Sabbath evening at Fishkill on the Hudson. He had been for many years associated with Columbia College and the schools at West Point, during which time he has been the author of numerous text-books.

At the age of 75 years, Professor E. S. Snell, the scientist and philosopher of Amherst College, has passed from life. He was the first student to enter Amherst, and was the last surviver of his class—the class of '22. He died at his home in Springfield, Mass., yesterday, and leaves an enviable reputation as a philosopher and cultured gentleman.

During the siege of Paris experiments were begun but not finished, to ascertain whether telegraphic communication could not be established with the river Seine as a conductor, instead of the usual wire. The problem is one which has long attracted attention, and it seems settled that feeble signals may be obtained, at moderate distances, by using a strong current and large metallic surfaces.

An exchange says: The Boston & Albany railroad recently took off a set of steel car wheels that had run 523,000 miles—a greater distance than was ever run by any car wheels before in this or any other country. The average running distance of a common chilled iron car wheel is only 30,200 miles. These steel wheels, which are rapidly coming into favor on the leading roads, are warranted for 300,000 miles, after which they can be turned down and used again.

The new life-saving stations on our Lakes, nine of which have been or are to be built this year, are 20x45 ft., 1½ stones high, with two rooms in the first story and four above. On the roof is a walk-way and look-out. The roof is painted red and the side lights drab trimmed with a darker shade. These stations are to be furnished with life-boats and all the requisite appliances for saving life amounting in value from $2,000 to $3,000. A crew will be employed during the season of navigation, the station to be in the charge of one man during the winter.

Discharge of Water from Jets and in Long Mains.*

The accompanying plate exhibits graphically the quantities of water discharged from jets and in long mains, under different heads.

The horizontal lines are proportional, in distance from *zero*, to the theoretic velocity of a jet of water issuing from that head. Then a series of quantities calculated for any stream at different heads will, on the scale lie on a straight line terminating in *zero*.

The flow of water in long mains of pipes seems to follow the same law, and it is probably applicable to other quantities.

The lower table represents, in gallons per minute, the flow of water from jets varying from ½ to 3 inches diameter, under heads from 1 to 300 feet.

The upper scale represents in the same manner the flow in long lines of pipes, from 6 to 26 inches diameter under heads from 1 to 300 feet per mile.

Similar scales can be constructed, which will give any required number of quantities; that from which this was taken has over 5000.

Feb'y 15, 1876. GALEN W. PEARSONS, Engineer of Water Works, Bangor, Me.

Reports of Committees of the American Society of Civil Engineers.

ON SECURING A NATIONAL RECOGNITION OF THE SOC'Y.

The Committee to which was referred the subject of "Securing a National Recognition of the Society by Federal Charter or otherwise," respectfully offers the following report:

After due consideration, the opinion of the Committee is that the primary advisable plan of securing a national recognition of the Society, is through a federal charter. If this can be obtained, it will not only secure the recognition of the Society by the government, but it will change the comparatively local status, arising from its present corporate existence under the laws of a single State. Our members reside in various States, scattered over the Union, and some of them belong to other countries; so that the membership is already quite national, as well as to some extent cosmopolitan.

Within the last few years the Society has increased its membership much more rapidly than formerly, until it now numbers in all over five hundred members, who combine a vast amount of varied experience in every branch, not only in civil engineering proper, but in many of the allied branches of scientific and mechanical engineering.

For a number of years the Society waa in a comatose state, and nothing was done beyond keeping up the organization, without meetings or work of any kind; but during the last ten years efforts have been made to imbue it with fresh life and energy, through more frequent meetings and publications of numerous papers contributed by its members; and also by encouraging the admission of new members. These efforts have been attended with great success, and the Society is now a live working organization, in good standing at home and abroad, and giving promise of annually augmenting its influence and worth.

The Society has advanced rapidly in public estimation; and, by its conservative course, it has, we think, deserved the general favor which is now extended to it.

Its latest forward movement, in the appointment of a Centennial Commission, composed of its own members, for the purpose of exhibiting in the International Exposition in Philadelphia, the progress and practice of American engineering, will, it is believed, be the means of inaugurating a very interesting feature, which promises to benefit not only members of the Society and others in our country, but many of the visitors from other lands, and from other societies. The fact that the funds for this purpose have been raised by voluntary subscriptions among its members and other gentlemen and other organizations friendly to the undertaking, without drawing from the funds of the Society, shows that there is a commendable spirit of liberality and enterprise among its members, entitling the Society to most favorable consideration.

Although the leading object of the Society is the mutual improvement of its members professionally, this professional improvement naturally and inevitably ramifies and sends its influence through all the parts of our vast country, and even extends beyond its boundaries into other regions, wherever public improvements may be in progress.

Its chief design is to elevate the tone and enlarge the sphere of operations of the American civil engineer, and thus to render him capable of fulfilling his very responsible duties, not only with more credit to himself, but with more profit and greater safety to the public, in whose behalf the bulk of engineering works are planned and constructed.

Therefore, to some extent, the strengthening of the hands of this Society is a practical insurance, as it were, upon the public improvements of the country; whether they consist of canals, reservoirs, harbors, rivers railroads or bridges, etc., or of ships, forts and armaments; and it is a mutual insurance which tends to the protection of all classes. It should be, and we trust it will be, the pride of our country, not only to favorably recognize the American Society of Civil Engineers, but to extend toward it a liberal and enlightened recognition; such as will command the respect of all civilized governments. There is already a gratifying mutuality of feeling between this Society and other analogous associations in Europe, and in the United States; and this friendly feeling will probably be greatly strengthened during the continuance of the World's Exposition. In fact, the whole scheme of the Centennial—the planning and construction of the various buildings, their arrangement, their adoption to the different specialties, and the endless variety of the things to be exhibited, will be eminently interesting to civil engineers from all parts of the world.

The United States government, representing the whole American people, may not only properly take notice of this Society, but materially aid its beneficial labors, by encouraging and assisting, pecuniarily, such valuable experiments as are beyond the means of individuals or of private organizations.

In view, therefore, of the circumstances, we recommend to the favorable consideration of the Society an application to Congress for a national charter, upon the most favorable terms which may consistently be granted keeping in view mutual advantages between the Society and the country.

Respectfully submitted.

W. MILNOR ROBERTS, THEODORE G. ELLIS, Of Committee.

TESTS OF AMERICAN IRON AND STEEL.

At the Eighth Annual Convention, June 15th last, the annual report of Committee on tests of Iron and Steel was submitted, accepted, and the Committee requested to prepare an appeal to members of Congress to be sent, with a copy of the report, to each member of the Society.

In compliance therewith the following was submitted:—

So rapid has been the increase in the production of iron and steel in this country, and so varied and multiplied have the uses to which these metals are applied become, that the scientific research necessary to an accurate knowledge of their qualities and a judicious application of these metals, has become a work of such magnitude that it cannot be performed by any private individual or corporation, Such research has therefore not kept pace with the growth of the manufacture of the metals and the multiplication of their uses.

The partial investigations which have been made have resulted in very great benefits. Our government as such, consumes enormous quantities of iron and steel for army and navy purposes, and in the construction of public buildings. The officers charged with the application of iron and steel to these purposes are as well informed as to the qualities and characteristics of these metals as any other class of our people, and yet they feel and appreciate the uncertainties through which they are compelled to grope their way to a practice which, if rigidly correct, is merely by accident.

All the iron and steel makers of the country are painfully conscious of the ignorance which exists, and hail with gratitude the action of Congress appropriating money to remove it. So universal is the use of iron and steel by our people, that all classes are deeply interested in having such accurate knowledge of these metals procured as must lead to safety and economy in their employment. For this reason a most lively interest has by all classes been manifested in the work of the United States Board to test iron, steel and other metals, and the chagrin and disappointment which would mark the failure of the Board for want of the appropriation asked would be correspondingly bitter. Have not the industrial classes a very strong claim upon Congress to have these tests made in their interest, which the government as such cannot afford to neglect for its own.

Four of the members of the Board are salaried officers of the government, and the remaining three members receive no compensation, except that the Secretary is paid $1,200 per annum for the performance of very arduous duties.

The testing-machine in course of construction for the Board is believed to be the most perfect one ever designed. It is now approaching completion. Meantime, the tests and investigations to be made by the Board, have been carefully planned by the various committees appointed to make them. And such of the committees as have been able to work without the machine, are busily engaged and have reached very valuable results. The plans of the Board and its labors thus far have received the hearty approval of the best scientists and practical men of this and other countries, and they have been strongly endorsed by institutions of learning, learned societies, and industrial associations throughout the United States.

The knowledge already obtained by the Board will be worth to the government in a single year many times the amount of the money appropriated, and it must be borne in mind that this knowledge once obtained is perennial. If sound economy prompts the expenditure of a small sum of money to save a very large one, it surely demands that Congress shall appropriate the $50,000 asked for the work of the Testing Board during the next year.

The labors of the Board have already resulted in the discovery of a method whereby wrought-iron bars may be made of uniform strength per square inch, whatever is the section. Heretofore that strength has decreased as the size of the bar increased. This discovery is of very great value. They have also led to the rejection of the standard test of the chain cables used in our navy and merchant marine, and the adoption of a correct one. The importance of this change will be appreciated when it is known that anchor chains were so injured by the established test that they were upon the point of breaking, and did break when used, from the injury they had received while undergoing test. The great loss of life and property resulting from the failure of the metal parts of bridges, buildings and machinery, can be in very great measure prevented—and will be—by the use of the knowledge which the researches of the Testing Board will develop.

The work of the Board is thoroughly planned, and progressing most satisfactorily. Public safety and economy demand its continuance to completion; and this is now so widely and so well understood that the appropriations necessary will be approved by all classes. On the other hand, the failure of Congress to make them, will result in continual heavy losses to our Government and people, and great constant danger to life and property. WM. SOOY SMITH, Chairman.

On Estimating the Illuminating Power of Coal Gas.

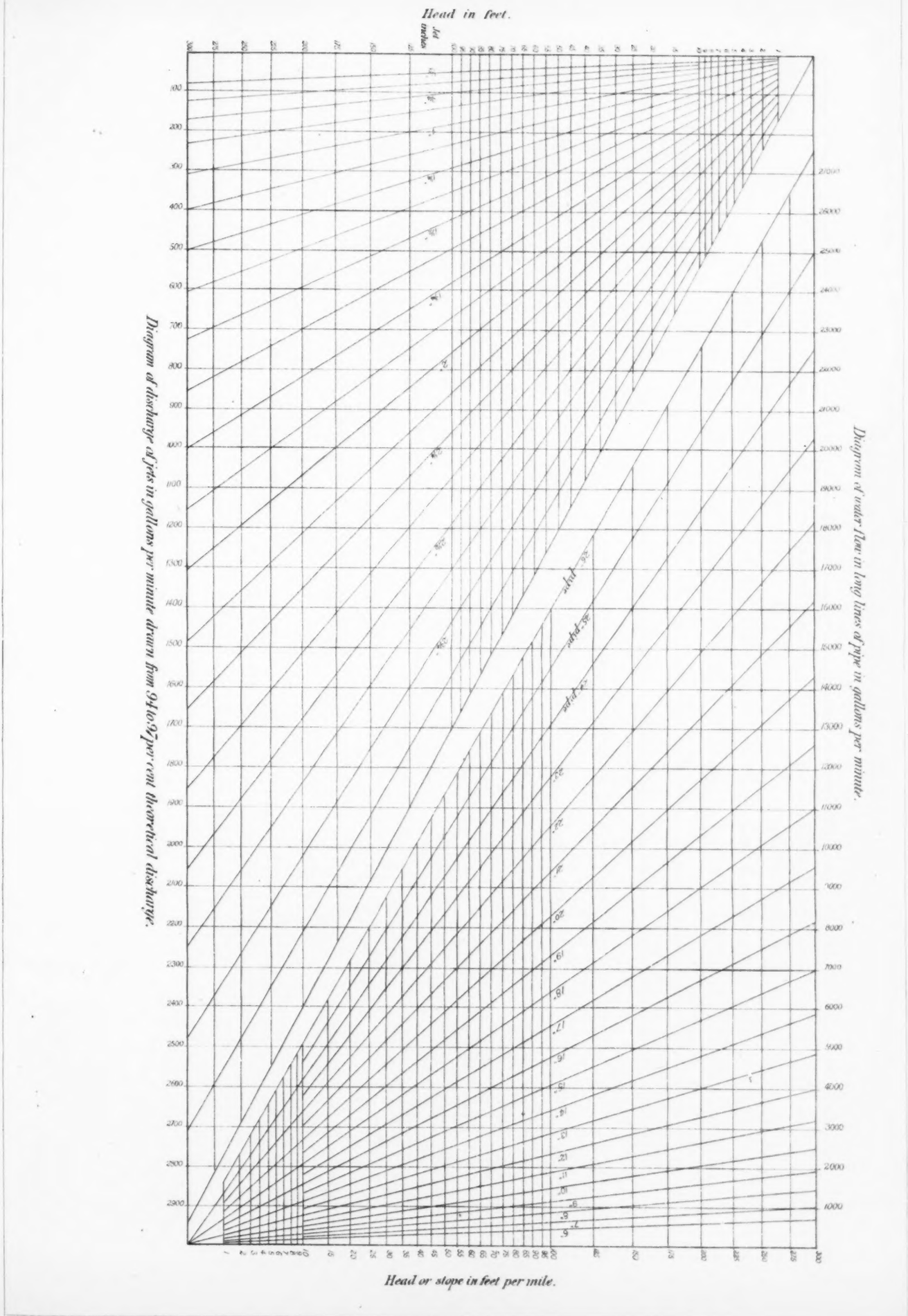
BY WILLIAM SUGG, Assoc. Inst. C. E.

[A paper read before the Institution of Civil Engineers.]

Notwithstanding the attention which, almost from the commencement of gas-lighting, has been bestowed upon this important subject, yet gas photometry is still in an unsatisfactory state. With even the most perfect apparatus, the same quality of gas is differently estimated in various places, because there is no generally recognized standard burner. There is, consequently, a want of uniformity in the results of different operations, which inclines those who are not conversant with the subject in all its bearings to distrust photometrical tests, and to despair of obtaining more than an extremely rough estimate of the amount of light-giving power of any sample of coal gas. This applies with greater force, at the present time, to the estimations made by the public examiners than to those by gas-makers.

Since the elaborate series of experiments carried out by Mr. T. N. Kirkham, M. Inst. C. E., Engineer-in-Chief of the Imperial Gas Light Company, assisted by

* From the Journal of the American Society of Civil Engineers.


Head in feet.
Diagram of discharge of jets in gallons per minute drawn from 94 to 98 per cent theoretical discharge.
Diagram of water flow in long lines of pipe in gallons per minute.
Head or slope in feet per mile.

the Author, gas-makers have been in possession of reliable means for their purpose.

One of the results of these important experiments is that the jet-photometer, originally invented by the late Mr. George Lowe, M. Inst. C. E., has been so improved through the data thus obtained, that it is possible to ascertain by simple inspection the true illuminating power capable of being envolved from different coal gases. Thus, the manufacturers of gas are able to satisfy themselves reasonably well of the illuminating power, and consequently of the commercial value, of what they sell; whilst the public are not so well able to appreciate at its proper value the gas they buy, the jet-photometer not being a parliamentary test, and so not being used by the public gas examiners. This is probably the reason of much of the dissatisfaction expressed by the public in England and in other parts of the world relative to the gas supply.

The official certificate given in terms of the parliamentary standard candle, and of the various standard burners, does not always show the real light-giving power of the gas, neither does it appear to convey a sufficiently clear idea of its monetary value to those, unacquainted with gas photometary, who have to pay for it. The Author feels confident that this state of things may be altered, and satisfactory results obtained, by a modification of the apparatus at present in use for the purpose.

It is generally acknowledged that the most accurate way of estimating the illuminating power of gas is by burning a known quantity of that gas in a standard burner, and comparing the light with that from a known quantity of oil or sperm consumed in a certain kind of lamp or candle.

In England, since the year 1852, the parliamentary standard of comparison has been a sperm candle, of six to the pound, burning at the rate of 120 grains per hour. As the result of an elaborate series of experiments conducted by Professors Graham, Brande, J. T. Cooper, and Dr. Leeson in 1852, may be stated that the average normal rate of burning of these candles is nearer 130 grains than 120 grains. Therefore it is desirable that the parliamentary standard rate should be altered, if a change can reasonably be made.

The greatest obstruction to the adoption of a uniform system of gas photometry has always besn the difficulty of settling the kind of burner through which the gas to be tested shall be burned. With the standard quantity of the same gas, different kinds of burners give varying results with an identical quantity of gases of different illuminating powers, richer or poorer, according to the quality of gas it has been originally designed for. Thus, as an example of the first difficulty, in 1863 Dr. Letheby found that seven 15-hole standard burners, provided with 7-inch chimneys, gave, for a consumption of 5 cubic feet per hour of the same gas, varying powers of light from 11.30 to 13.56 candles, or a range of 20 per cent. Yet these were all eligible as testing burners, because they agreed with the extremely vague description of the standard burner in the Metropolis and other Gas Acts, the work of the Acts being generally, "a 15-hole Argand burner provided with a 7-inch chimney." As an example of the second difficulty, the present standard burner for the City of London does not, when made to burn a constant quantity, develop the illuminating power of more than one quality of gas. Thus, if it be supplied with 5 cubic feet per hour of 16-candle gas, it will burn it very well, and give nearly true results; but with 5 cubic feet of 17- or 18-candle gas it ceases to do so, although it would succeed with a proportionately less amount of the richer gases. The reason is that the air and gas passages are arranged to burn 5 cubic feet per hour of 16-candle gas; richer gases, therefore, cannot get enough air for their proper combustion, and so the burner does not educe the full amount of light these gases are capable of evolving.

If gas is to be tested by the amount of light attainable from an unvarying rate of consumption of 5 cubic feet per hour, then it ought to be a *sine qua non* that this standard quantity be as properly burned as a consumer can burn it. To do this, not one only, but several standard burners are required. To Dr. Letheby belongs the credit of having made one of the first important steps towards an acurate estimation of the illuminating power of coal gas, for upon finding the great differences which existed in so-called standard burners, he, in the year 1863, designed, in conjunction with the Author, a standard burner with a 15-hole incorrodible steatite top for 14-candle gas. Previous to this all official testing burners had iron tops, which were subject to alteration by oxidation. With this burner the gas supplied to the City of London was tested until the appointment of the referees under the Metropolis Gas Act of 1869. Dr. Letheby was the first public examiner who introduced arrangements in the photometrical instruments for cutting off reflected light from walls, ceilings, &c.

It must be said, however, in justice to Mr. George Lowe, that, being aware of the necessity for a proper standard burner, he, so far back as the year 1859, urged the Committee on the Chartered Gas Bill to adopt the first one made by the Author for 12-candle gas with a steatite top and 15 holes; but his proposition was successfully opposed. The burner adopted by Dr. Letheby, known as the "Sugg-Letheby" 14-candle burner, is one of the parliamentary standard-testing burners for 14-candle gas, and is used with a chimney 7 inches long and 2 in. wide, in England, in some parts of North and South America, in Canada, Australia, and New Zealand. There are, however, two other parlimentary burners for 14-candle gas, viz., one described in the Birmingham and Staffordshire Gas Act of 1864, for testing the gas supplied to Birmingham, and also adopted at Hanley, Hull, and, till lately, at Brighton. It is of the 15-hole class, and is used with a similar chimney to the preceding one; the top is of hard bronze; but it equally unsuitable for ordinary use or for testing burner. The other 14-candle burner is that adopted by the Gas Referees for London in 1869. The words of the Act (City of London Gas, 1868) under which the referees were appointed are with respect to the standard burner: "Section 43. The Gas Referees shall prescribe the burner for testing the illuminating power of the gas, and it shall be such as shall be the most suitable for obtaining from the gas the greatest amount of light, and be practicable for use by the consumer."

This burner, the invention of the Author, is known as Sugg's "London" standard Argand burner for 14-candle gas, and is used for testingt he gas supplied to the City and other parts of London by the Gas Light and Coke Company, by the Imperial and South Metropolitan Gas Companies, and by a number of companies in the provinces. It is also the new standard burner for the Dominion of Canada, and the Author believes for New York, Philadelphia, Chicago, and some few places on the Continent of Europe.

The same standard quantity of the same quality of gas tested by these three burners shows very different powers of light, the "London" burner evolving the greatest, and the Birmingham the least amount of light. The total difference is nearly three candles.

There are three different parliamentary standard burners for testing 16-candle gas, all to consume the standard quantity of 5 cubic feet per hour, viz., the "Dublin" 16-candle Argand 15-hole steatite-top burner, used with a chimney 7 inches long by 2 inches wide, specified in the Dublin Gas Act. This is a modification of the "Letheby" burner, the only difference being that the central aperture for the admission of air is larger than in the "Letheby," the richer gas requiring more air for its combustion. The Dublin flat-flame 16-candle burner, specified in the Dublin Gas Act of 1873 to burn 5 cub. feet of gas per hour under a pressure of 0·5 inch. And the "London" standard Argand for 16-candle gas with a 24-hole steatite top, to be used with a chimney 6 in. long and 2 inches wide. The last is the same as that adopted by the Gas Referees for testing 14-candle gas, the only difference being in the increased diameter of the chimney.

The Gas Referees likewise direct in their instructions to gas examiners, with a view of getting a more nearly correct estimation of the power of richer gases than 16-candle gas, that in the event of the flame from the standard quantity tailing over the 6-inch chimney a 7-inch one is to be substituted for it.

At the time the referees were called upon to prescribe the standard burner for 16-candle gas, no other of that kind existed than the Dublin burner, which does not comply with the requirements of Parliament, inasmuch as it is not the best burner for the use of the consumer, neither is it a good testing burner. The standard quantity of the same quality of gas affords different degrees of light with each of these three burners. The London burner gives the greatest, and the Dublin "Argand" burner the least light. The total difference varies from about 1½ to 1¾ candle.

There is but one parliamentary standard burner for consuming 5 cubic feet per hour of 18-candle gas, viz., that described in the Leamington Gas Act, which is a modification of the "Sugg-Letheby" burner, the central aperture being enlarged to supply more air to the richer gas. It is not much used, and is not the best burner for the consumer. The difference in amount of light given for the standard quantity of the same quality of gas consumed in the "London" 18-candle burner and the Leamington burner is about 2½ candles; the "London" burner yielding the greatest, and the Leamington the least light. For 20-candle gas the parliamentary standard burner is described by the Gas Referees as Sugg's steatite batwing, No. 7. It is used in London and in Liverpool. There is another which is described in the Dublin Gas Act, and which it is specified shall consume 5 cubic feet per hour at a pressure of 0.5 inch of water at the point of ignition. The difference between this and Sugg's steatite, No. 7, is 2½ candles with 20-candle gas.

The Argand burner is erroneously supposed not to yield so good a result in burning 5 cubic feet of Cannel gas as the batwing burner. For 27- up to 32-candle gas, it is customary, in Scotland and elsewhere, to make use of any kind of fish-tail burner, and to consume any quantity of gas, at the option of the operator. For Cannel gasses there is no regularly authorized parliamentary burner, neither does it appear that custom has established one which might serve the purpose; so there is great uncertainty as to their true illuminating value.

From what has been stated it will be readily perceived that a revision of the standard-burner system is greatly needed. Evidence has been given, and probably will again be given, in Parliament relative to the cost of gas, which is absolutely enigmatical, excepting to those who are well versed in the question of standard burners. Now if the standard burner were as equally certain as a standard pint measure, so that it might be regularly stamped by the Standards Department of the Board of Trade, it would be known that 14-candle or 20-candle gas meant such a quality of gas that a consumer could, if he pleased, obtain from the combustion of 5 cubic feet of it a clear white light equal to fourteen or twenty sperm candles of six to the pound. But the success of those appointed to settle the question of standard burners has been very indifferent.

Naturally it will be imagined that the illuminating power of gas is the light it can be made to evolve. Such a starting point was for the first time agreed upon by the Engineer to the Corporation of the City of London, Mr. William Haywood, M. Inst. C. E., and Dr. Letheby, in their joint "Report to the Special Gas Committee of the Commissioners of Sewers," dated the 10th of December, 1864. In giving the reason for the adoption of the "Letheby" burner for testing purposes, they state, that "as no burner can produce light, but merely educe it, they (the gas companies) are entitled to all the light which can be evoked from the gas by any burner which fulfils the conditions of the Act of Parliament." This, at that time novel view of the case, was after careful examination confirmed by Mr. Cardwell's committee on the Metropolis Gas Bill of 1868. Since then the only standard burners which have been adopted are the Gas Referees' (London) 14- and 16-candle burners, and the Dublin flat flame burner, which is only used for testing the gas supplied to the city of Dublin. All others were adopted before this principle of selection had been agreed upon.

Now it is evident that, as the guiding principle recommended by Mr. Cardwell's committee will influence the selection of standard burners for the future, there must be as many standard burners as there are different qualities of gas, supposing all are to be tested by burning a uniform quantity of 5 cubic feet per hour. Such a system will take much time to perfect, and will require great care on the part of the gas examiner. In fact, he must know before he makes the test what is the light-giving power of the gas, so that he may use the right burner to develop its qualities. Strange as it may appear, there is no difficulty with a proper set of standard burners in arriving at this conclusion, by finding which of the standard burners will burn the required 5 cubic feet of gas per hour giving a flame of, say, 3 inches in hight. If, for example the 16-candle standard burner

will do this, then the gas is equal to sixteen sperm candles, and the subseqnent test will only be a corroboration of the fact.

But the system invented by the Author is much simpler than that. One standard burner only is proposed for all qualities of gas from twelve to thirty candles. This burner may be readily gauged and verified by actual trial against the Government standard burner, as in fact the Gas Referees' London standard burners are now verified. The burner which the Author proposes as the standard burner for all gases is the Gas Referees' London Argand burner, with a chimney 6 inches or 7 inches long by 1¾ inch wide, producing a flame always 3 inches in height. To enable it to burn with a steady flame a slight modification must be made. This will then be the same kind of burner which is ordinarily adopted by consumers.

When used with 16-candle gas it will burn 5 cubic feet per hour with a 3 inch flame, the light from which will be equal to that given by sixteen sperm candles of six to the pound.

The following table shows the quantities of different qualities of gas required to produce in burning a 3-inch flame with this burner, viz.:—

With 12-candle gas it requires			6.65	cubic feet.
" 14	"	"	5.72	"
" 16	"	"	5.0	"
" 17	"	"	4.7	"
" 18	"	"	4.4	"
" 19	"	"	4.2	"
" 20	"	"	4.0	"
" 25	"	"	3.2	"
" 30	"	"	2.6	"

Of late years a Gas Referees' standard burner has been constantly used by the Author as a standard light for testing various kinds of gas burners, and it has been found that the illuminating power, as well as the appearance of the 3-inch flame, has been always constant, notwithstanding considerable variations in the quality of the gas. On several occasions it was tried with two different gases, one quality of gas being equal to thirteen candles and the other to twenty candles; but the most careful observation failed to detect the slightest variation in the amount of light given by the standard 3-inch flame. Only the quantity of gas supplied to it was gradually lessened, and the pressure at the foot of the burner was proportionately diminished as the richer gas displaced the poorer, and *vice versa*.

For the convenience of gas examiners, the Author has prepared a table showing the illuminating power of gases, the quantity required to give a 3-inch flame to this burner having been ascertained.

This system of a constant flame is founded on the jet-photometer system explained in the Paper on "Experiments on the Standards of Comparison employed for Testing the Illuminating Power of Coal Gas," by Mr. T. N. Kirkham, and also upon the old Scotch duration test invented by the late Dr. Fife. These systems are combined with the present parliamentary system of ascertaining the illuminating power of gases by comparison with the light of the flame of a sperm candle. The proposed method of effecting this is as follows:—The Gas Referees' 3-inch flame burner having been fixed on a photometer in the place usually occupied by the standard burner, it is to be lighted, and allowed to burn off all the dead gas collected in the meter and fittings of the apparatus. Then, a clean chimney is to be put on, and the height of the flame regulated by the aid of the usual micrometer cock and King's pressure gauge to exactly 3 inches. The quantity of gas per hour required to give this flame is then to be found, and a reference to the table will show the examiner the illuminating power of the gas. The rest of the experiment is performed in accordance with the instructions of the Gas Referees. The result is the illuminating power of the gas in terms of the parliamentary standard quantity of 5 cubic feet of gas and 120 grains of sperm candle. Every quality of gas tried upon this system will be fairly consumed, and a like quantity of gas will be designated by the same number of candles of illuminating power.

In conclusion, it must not be supposed that because there will sometimes be a divergence between the illuminating power as found by the candles, and that indicated by the Author's table, the system here described is uncertain or variable. The steadiness of the standard light enables the examiner to detect the variations in the illuminating power of the sperm candles, which he has not previously been able to discover. A reference to Mr. Kirkham's experiments will demonstrate to which of the two, candles or standard flame, the discrepancy, if any, is to be attributed. — [The discussion of this paper will be published next week.]

The Centennial.

COMPRESSED AIR ENGINE MADE BY THE STUDENTS OF THE PHILADELPHIA POLYTECHNIC COLLEGE.

In order to illustrate the practical working of this new system of Compressed Air Propulsion, the Students of the School of Mines, and of the School of Civil Engineering united with those of the School of Mechanical Engineering in the construction of a line of railroad, both level and inclined, on which to exhibit the Locomotive.

Without fire, steam or smoke, and without cogwheels rolling on the track, the engine ascends a grade of one foot in five, by means of a motor which, once compressed, may be kept ready for use, and be obtained through suitable conduits at any point required.

To impress upon the mind of the visitor the fact that this system is well adapted to mining purposes, a model of a section of the shaft of a mine was constructed about one foot square in its cross-section, and eight feet high, covered by the floor and frame work of the ore shed and machinery house surmounted by its belfry. Against what represents, in plaster, a rocky hillside, which rises above the summit of the mine, and descends to a lower level beyond, the roadbed of the inclined plane has been built, and cross-ties laid. These ties are continued over trestle work to the abutment of a deck-bridge, one arch of which, with its supporting pier, is finished. The whole structure occupies space 15 feet long, and is about 9 feet in its extreme hight. Throughout this length a single track of rails is laid.

THE ENGINE.

The model of the engine, which has been construct ed on the scale of an inch to the foot, consists of a nearly cylindrical copper air chamber, resting horizontally on four standards, which contain the journal boxes of the wheels that support the machine.

The driving wheels are horizontal, and are two in number. They revolve in opposite directions beneath the air chamber, where they are set and properly supported, one on either side of the middle of the bottom. The two horizontal cylinders and their pistons, connecting rods, valves and valve rods, do not differ materially from those of ordinary steam locomotives.

The track has a third or plate rail fastened edge-wise, midway between the T rails and high enough to run between the two driving wheels. By means of a lever these wheels can be brought and retained sufficiently close together to pinch or press between them the central rail, and this pressure can be so increased as to hold the engine securely on steep inclined planes, or by the revolution of the driving wheels to propel it up or down at the speed required.

The reservoir of compressed air, under a pressure of about thirty pounds to the square inch, stands at the foot of the plane; and from it a ⅜ inch pipe-line is laid just outside the outer rail, and extending to the head of the plane.

In this pipe are three "air stations, one at either end of the line, and one on the plane, so that should the pressure in the air chamber fall too low, a fresh supply of compressed air may be drawn by stopping the engine at one of the "air stations" attaching a rubber pipe and opening a stop-cock.

In applying to low grade railroads whether elevated, underground or surface, the system of compressed air locomotion, as worked out and publicly illustrated by the students of the Polytechnic College, the middle rail of the track and the horizontal driving wheels are dispensed with and the traction is obtained by the ordinary vertical drivers.—(*Communicated.*)

Railway News.

The total value of railroads completed in Kentucky is estimtaed at $35,000,000

We learn that the Dakota Southern Railway is to be extended westward from Yankton, immediately.

A proposal is made for constructing a subterranean railway, nearly fourteen miles long, under the streets of Paris, the outlay being estimated at £5,480,000.

The Galt and Ione Railway, California, is nearing completion, and it is expected will be finished by October 14th.

Grading is nearly finished and tracklaying has begun at Milan, Ill., on the Rock Island & Mercer County Railroad.

One span of the railroad bridge, one hundred and eighty feet long, over the Tennessee river at London, was blown down Sept. 10th.

The narrow-gauge railroad has diminished nearly one half the $450,000 a year which Lynn, eastern Massachusetts, formerly paid the Eastern Railroad.

A project is afoot to organize a company to build a road from the present terminus of the West Wisconsin Road, now in a quiescent state, to Rice Lake, Barron County, Wis.

But four and a half miles of the Helena & Iron Mountain Road out of the forty-eight between Helena, Arkansas and Forest City remain to be graded, and the bridge and trestles are well advanced.

It is said that arrangements are being made to extend the St. Louis, Lawrence & Western Railroad from its terminus at Carbondale, Kansas, southward through Lyndon to Melvern, about twenty-two miles.

The survey of the proposed railroad from Bethel to Rochester, Vermont, has been completed. Work will soon be commenced, and the road, when completed, will connect with the Central Vermont at Bethel.

The Columbus and Southeastern road, Ohio, has been incorporated, with a capital stock of $1,500,000. It is to be an auxiliary line to the Sciota Valley road, and to run from Ashville to Murray City, Hocking county.

The Waukon and Mississippi railroad, Iowa, is graded, bridges built and ties on the ground. Arrangements have been made for the purchase of the iron and rolling stock and the road will probably soon be in operation.

Articles of Association have been filed for a company calling itself the Chicago and St. Louis Air Line Narrow Gauge road .This is believed to be a move to defeat the Chicago, Braidwood and Southern road which is now in condition to insure its early construction.

The Indianapolis Journal says that work has been resumed on the St. Louis & Bloomfield Road. The track and tunnel are being put in good order and trains will soon be put on the finished section, which extends from Switz City, Ind., southeast thirty-five miles to Bedford.

The work on the Hoosac tunnel was first earnestly commenced in 1855, and is said to have cost, up to January 1, 1876, about eleven and a half millions of dollars, to which may be added nearly four millions of dollars for interest, making a grand total of over fifteen millions of dollars.

A surveying party has reached Ovary, Colorado, from the terminus of the Utah Southern, 152 miles. It is rumored they are to work in the interest of the Central Pacific, who design an independent line from Ogden to Denver, connecting with the Kansas Pacific at that point.

The Natchez, Jackson and Columbus Narrow Gauge Railroad, three feet six inches, will be completed from Natchez to Fayette by September 10, twenty-five miles. Trains are now running regularly to within two miles of Fayette. The intention is to extend it to Jackson, Miss., forty-four miles beyond Fayette.

The Atlanta Times says the work of the Marietta & North Georgia Railroad goes bravely on. When completed it will open up to the State one of the most important and valuable thoroughfares within her borders. The region of country through which it passes is rich in resources, which only await the hand of enterprise to develop and grasp.

The route of the Massillon and Coshocton railroad, Ohio, now in course of construction, extends from Beach city, a point on the line of the Cleveland, Tuscarawas Valley and Cleveland railroad, to Coshocton, about thirty-six miles. From Beach city to Cleveland the distance is eighty-six miles, making the entire distance from Cleveland to Coshocton 182 miles.

A wooden narrow gauge is building in Florida, from Ocala to Blue Spring, via Silver Spring. This will complete the connection between the waters of the Atlantic and the Gulf by a transit of twenty miles, the rest of the route being made up of the St. Johns and the Ocklawaha on the east, and the Withlacoochee on the west. This will develop an extensive orange region.

The old road-bed lying between Ottumwa and Sigourney, Iowa, and which belonged to the Cedar Rapids and St. Louis, has been purchased by the Chicago, Burlington and Quincy, and the work of completing it has been commenced between Ottumwa and Iowa City. At the latter place the line will connect with the Clinton and Southwestern, also owned by the Chicago, Burlington and Quincy, thus giving that company another line from Chicago via Mendota to Council Bluffs. This new line will probably be used for freight especially, and is 20 miles shorter than the one via Burlington. The Mississippi will be crossed by a pontoon bridge at Clinton.

The New York *Sun* says:—Some time ago the Lehigh Valley Railroad made a contract with the Erie Railway by which it agreed to lay a third steel rail from Waverly to Buffalo, thus making a narrow gauge for 170 miles, in consideration of being given the right of way for trains over the section for a term of years. The rails were laid, and the traffic sent by the Lehigh Valley railroad over the Erie, so far, has amounted to enough to pay for twenty miles of the steel rail. It is thought that in about two years the Lehigh Valley will have used the road to an extent sufficient to reimburse itself for advances in the purchase of the steel rails. The rails will then become entirely the property of the Erie Railway.

Contractors' Intelligence.

Two hundred and twenty-seven miles of the Canadian Pacific Railroad from Red River to Thunder Bay are under contract and the most of this section will soon be located.

A dispatch says,—The bridges and piling on the Green Bay railroad extension, running into La Crosse Wis., were completed Sept. 18. The iron will be laid and trains running by Sept. 20.

The contract to grade the remaining portion of the C. C. and W. Railway between Clinton, Iowa; and Tipton was let Thursday. The work of grading is proceeding along the line. Some rolling stock has been purchased.

The contract for the foundation work of the Masonic temple, at Omaha has been let to Fred. Drexel, and correspondence is in progress about the iron work. It is expected that bids for the superstructure will be advertised for in a few days. The building will be completed this fall, if possible.

The contract to regrade, recurb and repave with Belgian blocks, Broadway, Baltimore, between the market house and the county wharf was awarded to J. Edward Kirby, the lowest bidder. The council committee on highways will recommend that the street on both sides of the market be also paved with Belgian blocks, which provision was unintentionally omitted in the ordinance.

The plan submitted by Engineer Davis, of Allegheny, Pa., to afford a better supply of water in that city, will be considered by the Council at its next regular meeting, which will be held Thursday night, Sept. 14. The plan involves an outlay of $102,000. It is said that a responsible firm offer to do the work contemplated in the engineer's plan for $73,000. No doubt their proposition will be duly considered.

The city council of Racine, Wis., received bids Sept, 18, on the new bridge to be constructed across Root river at the foot of Main street. There were nine bids turned in, of which the lowest was $14,879, by S. Soulerin, of Chicago. All bids were rejected because they were not within the limit, $12,000. The council will now reconsider the subject of the bridge plans, and will probably advertise for bids to build a bridge on the plans submitted by James, of Milwaukee. This will give a lighter structure, which the contractors can probably afford to build for less than $12,000.

General G. K. Warren, of the Engineer Corps, left Washington, D. C., Monday night, for Chicago, under orders to examine thoroughly the upper Mississippi, the Falls of St. Anthony, and the works at Des Moines, Rock Island, and on the Illinois river, with a view to estimating the smallest amount that will be required to preserve the work done under the river and harbor appropriations. Major Henry L. Roberts has returned to Milwaukee with the amounts allowed him for work at Marquette, Ontonagon and other points on Lake Superior and Lake Michigan.

An iron screw-pile pier, 600 feet long and 40 feet wide, is to be put up at Long Branch at some point on the beach not yet selected. It is to be modeled, to some extent after the pier at Brighton, England, and will rest on iron piles held by the tough blue clay strata found about four feet beneath the sand. The pier will be built at the expense of a number of investors who expect to be repaid by the sale of restaurant privileges, the charge of a price of admission, and the returns from allowing foreign vessels to land their cargoes there, thus saving port dues and pilot fees to New York. The structure will be both substantial and beautiful.

We learn from an exchange that the plans for the new music hall in Cincinnati Ohio, to be erected with what is known as the Springer fund, have been decided upon. The hall will occupy the site of the old Exposition building, and will have a seating capacity for 5,500. The length of the building will be 325 feet, width 182 feet; the hall proper will be 160 feet long by 112 feet deep, with corridors 18 feet wide on each side, and a vestibule in front 42 by 112 feet. The stage will be constructed after the style of that used during the late musical festival in which Theodore Thomas' ideas were expressed. The style of the building will be Italian gothic. The material has been contracted for and work will commence at once.

The new Water Works tunnel has been completed, and water has been let in. Saturday morning a flag was hung out at the crib signifying that the gate had been opened and a full head of water is now entering, and the engines are pumping from it to the reservoir. This improvement is one of the most substantial of the city, and affords a sense of security in the matter of abundant water supply. The contractor, General A. A. Macdonell, has finished his work in a masterly manner and to the entire satisfaction of the Trustees. He did the work in a most remarkably short space of time, and yet did it well. He built the lake tunnel and this with several other contracts has established his reputation as a responsible and competent engineer.—*Cleveland Plaindealer.*

The Diplomatic Appropriation Bill, as finally passed, abolishes the missions to Portugal, Switzerland, Greece, Denmark, and Paraguay, replacing them with Charges d' Affaires at $5,000 salary. It also abolishes the missions to Bolivia, Ecuador, Colombia, and Uruguay. Twenty-two Consulates are abolished, all others remaining with the same salary as heretofore. The European Consulates abolished are Southampton, Malta, Vladivostock, Oporto, Santa Cruz, Nantes, Rochelle, Port Mahon, Valencia, Stettin, Maranham, Cyprus, Bucharest, Venice, Milan; also Swatow, Port Said, and Hakodadi.

Roads, Streets and Pavements.

Few things, probably, are more conductive to the successful opening up of a new country than the judicious laying out and proper construction of roads, and as it is not at all times possible to procure the services of an intelligent road engineer, such works as that of Major-General Gillmore are almost invaluable. He has been careful to give such descriptions of the various methods of locating country roads and of constructing the road and street coverings in more or less common use at the present day as will render the essential details of those methods, as well as certain improvements thereon of which many of them are believed to be susceptible, familiar to any intelligent non-professional reader. He also makes some useful suggestions with respect to the selection and application of materials in order to develope their greatest practical worth and realize their greatest endurance, and further compares the respective merits of the street pavements now competing for popular recognition and favor with the varying conditions of traffic, climate, and locality to which they are commonly subjected.

The location and grades of country roads is first dealt with, care being taken to explain the elementary principles to be kept in view, aneroid barometers and their uses, methods of selecting the line, how to estimate questions of expediency, grades, statical resistances on grades, &c. Next, the earthwork, drainage, and transverse form of country roads are considered, methods of protecting embankment slopes, making hill-side roads, roads over marshes, culverts, catchwaters, &c. In the succeeding chapter the advantages and defects of the several kinds of roads—earth, corduroy, plank, gravel, MacAdam, Telford and other—are pointed out, and there are chapters on the maintenance and repairs of roads, streets and street pavements, side-walks and footpaths, and tramways and street railways. In referring to rubble-stone foundations to be used without Telford pavements, he recommends 7 to 8 inches of rubble for a road 12 in. thick, which cannot be objected to, but he goes on to say that the foundation should be constructed with great care, the large stone being laid down first, side by side, flatwise upon the road bed, firmly set to their places with rammers. The interstices are then filled in and leveled up with smaller stones, care being taken by selecting the pieces to get them to fit as closely together as possible, and thereby to mutually sustain each other in place.

The object is to use as much material in a given thickness as possible, so as to reduce the volume of voids to a minimum. Now, this scarcely agrees with what is now considered the best practice. Formerly roadmakers may have followed architects in stipulating for the rubble to be laid in the same way as it was originally laid in the quarry or "bedway down," as the laborers call it, but it is now ascertained that a much more solid and durable road is obtained by putting the handled rubble "toothway up"—that is, with the bedding vertical. When similar care is taken in packing the rubble the road is much superior, whilst carelessness on the part of the laborers is less prejudical – 9 in. of rubble, with 4 in. of metaling, makes an excellent road, with ordinary care.

The information conveyed in the volume is of a thoroughly practical character, and gives evidence of the author having had actual experience on the subject on which he writes, whilst the style in which the facts are put forward is such that they can be quickly ascertained and readily utilized.—*London Mining Journal.*

Water Works, Ancient and Modern.*

BY E. H. D'AVIGDOR.

(*Continued from page* 304.)

Frontinus, who was a species of superintendent of works in the city of Rome in the first century of our era, gives us many details about the water works then in their prime. He describes nine principal aqueducts deriving their supplies from four groups of springs, viz., the following: 1. One group near the banks of the Anio close to the city, from which Appia and Virgo drew their water. 2. The second on the hill side, east of the first, whence Hadriana, now Felice, rises. 3. The group between Tusculum and the Alban lake, whence came Tepula and Julia. These three groups of springs were all in the volcanic plain which borders Rome on the left bank of the Tiber. But the fourth group, the highest and most important, were in the limestone mountains above Tibur. Hence came Marcia, Claudia, and the two Anios. The level of the springs of Marcia was 316 metres, or about 1000 ft. above the sea; that of the outfall in the reservoir at Rome was 54 metres, or about 178 ft. The last aqueduct was Alsietina, which was not supplied by springs like the rest, but from the Lake Braciano on the right bank of the Tiber. Besides these nine aqueducts, of which a very full description has come down to us through Frontinus, many others were constructed at a later period, of which Hadriana, Alexandrina, Neroniana, and Trajana are the most celebrated. But I propose limiting my remarks to the nine older works, because we possess more accurate descriptions of them, and because time and space prevent our wandering too far in our Roman researches.

A description of a line of curves, gradients, and inclines is one of the most tiresome things possible to have to listen to, and if written or printed is invariably skipped. I therefore omit it altogether, and annex the map (See Plate No. 38) in its stead, and as an explanation of it Table I (see page 312), in which some of the principal data concerning ancient aqueducts are collected. I will merely draw attention to some of the most remarkable points. The total length of the nine aqueducts, up to the walls of the town, was 443 kilometres, or about 277 English miles. Of this enormous development about 49 kilometres, or 31 miles, were carried on arches. As may be perceived by the map, most of the aqueducts crossed the volcanic plains near Roma Vechia, after having kept to the hill-sides as long as possible. Here the numerous ruins of the ancient Roman water works are still visible; here the visitor admires those

* A course of papers delivered at the Austrian Institution of Engineers and Architects, December, 1875, and January, 1876.

TABLE No. 1.—COLLECTION OF THE MOST IMPORTANT DATA OF THIRTEEN WATER WORKS OF ANCIENT TIMES.

No.	NAME.	YEARS OF CONSTRUCTION.	LENGTHS IN KILOMETRES.	TUNNEL LENGTH IN METRES.	ARCHES LENGTH IN METERS.	GRADIENT PER 1,000	HIGHT ABOVE SEA LEVEL: OF SPRING.	HIGHT ABOVE SEA LEVEL: AT TOWN.	DESCRIPTION OF GROUND.	DAILY FLOW IN MILLIONS OF GALLONS.	REMARKS.
1	Appia	— 313	26.03	....	88.0	1.50	62	8.37	Volcanic plain	13.5	General use for watering streets, &c.
2	Anio Vetus	— 273	63.7	....	329	2.73	183	35.17	Limestone mountains	60	
3	Marcia	— 145	100.6	....	10.158	1.67	312	37.48	Ditto	21	Drinking water.
4	Tepula	— 126	18.8	....	610	1.55	?	38.23	Volcanic plain	0.5	Ditto
5	Julia	— 33	19.5	....	9.588	2.30	?	39.71	Ditto	10.0	Ditto
6	Virgo	— 19	25.2	800	1.037	1.54	70	10.43	Ditto	13.0	Purest water.
7	Alsietina	— 19	34.0	....	530	1.50	56	5.00	Lake	5.5	General use.
8	Claudia	+ 39	68.7	803	14.173	1.50	255	47.42	Limestone mountains	24.0	Drinking water.
9	Anio Novus	+ 40	86.9	802	13.023	3.00	250	48.12	Ditto	61	General use.
1–9	Aqueducts of Rome	.....	443.4	2405	49.537	....	....	....	.....	208.5	Rome and suburbs.
10	Nimes	+ 138	49.75	?	3.220	0.34	76	59.04	Limestone	6.5	Drinking water with modern siphons now in use.
11	Lyons (Pilatus)	+ 50	52.0	Ca 0.05	Ca 0.1	1 67	170	53.06	.....	5.0	
12	Metz. Restored 1854	+ 130?	22.166	....	....	....	....	....	Sandstone	9.3	
13	Antibes. Restored	? +1777	6.0	4940	....	0.41	....	....	Sandy marl	0.6	Ditto.

N. B.—The dates marked (—) are before Christ. Those marked (+) are after Christ.

rows of of massive piers and splendid arches, many of them still in the same condition as when they were completed nearly 2000 years ago, notwithstanding Huns, Goths, Vandals, and Time itself. There is no settling, there are no cracks, no flaws, nothing except what is obviously the result of carelessness or intentional injury. The ashlar arches of Marcia are still patterns for the mason, while the hydraulic mortar is still so hard, that the best Portland cement of the day will scarcely show a greater resistance to crushing. Above Tibur there is another point, the celebrated Valle degli Arci, where the four aqueducts which bring down the water from the limestone mountains, all cross the valley on a series of beautiful arches.

I must now call your attention to some peculiarities of the lines and direction of the aqueducts, which have long puzzled antiquarians and engineers alike. Appia is the oldest aqueduct, Anio Vetus was the next constructed, and the rest were erected successively at the different periods indicated in Table I. Now, as in modern towns, so also in Ancient Rome, it turned out that the old aqueducts did not supply the water at a sufficiently high level. The newer works were therefore invariably, if possible, constructed with their outfall higher than the old ones. This explains the curious fact that two or three aqueducts were built one on the top of the other. This mode of construction was the more plausible, as the line from the hill-sides to the very walls of Rome was indicated by nature itself by a low ridge. We find, therefore, that Tepula was built over Marcia, and 92 years later, Julia over Tepula (see Fig. 10).†

Another singularity of the aqueducts is the great difference in their respective lengths for an equal difference of level, and the same real distances. Thus Marcia commences close to Claudia, and yet Claudia, which was erected 100 years later, is 22 kilometres, or 30 per cent. shorter. People have long puzzled over a reasonable explanation of this difference, as well as of the frequent and abrupt changes of gradient. The real key gives a sufficiently probable reason for these apparent anomalies, as, indeed, much in the Roman art of building would still remain inexplicable were it not for the engineering and antiquarian researches of such men as Choisy, Leger, Belgrand, and Blumensthil. People fancied that the sharp curves, sudden twists, and broken gradients of the aqueducts were put in on purpose either to break or to increase the flow of the water at certain places. This appears to be an error. The real reason is probably no other than the defective nature of the Roman surveying instruments. Their level or "chorobath," consisted of a species of trestle from 10 ft. to 20 ft. long and 4 ft. to 5 ft. high. The top beam, about 6 in. by 6 ft., contained a small prismatic groove in the middle, 5 ft. long. The legs were secured by struts at an angle of 45 deg., and above the centre of each strut a brass nail was driven into the top beam. To this a plumb bob was attached, and the point of the strut cut by the line when the chorobath was horizontal carefully marked. The groove was filled with water when great accuracy was required, otherwise the position of the two plumbs was considered sufficient to indicate the horizontality of the instrument, a sight being taken along the top of the beam without any other apparatus. To set out a fixed gradient the one foot was raised at home till the instrument itself took the required angle; the new line now taken by the plum bobs was marked, and in the field the whole unwieldy thing was tilted or wedged up at each sight till the plumb lines took the required position. You can imagine that, with this instrument only, setting out an accurate gradient was a matter of impossibility, and that errors could easily arise which altered the desired gradient from 1 in 100 to 1 in 1000. It is almost a wonder that the Romans managed to give their aqueducts a constant inclination one way, and did not involuntarily construct siphons.

As to the cross sections of the aqueducts, the principal object of the Romans appears to have been to construct them sufficiently high inside to be easily accessible for repairs. They had no scientific data enabling them to fix the real cross section required for a certain quantity, head of water and fall; you perceieve, therefore, by Table I, that with the exception of Tepula, the principle of the aqueducts being accessible is pretty constantly adhered to, and certainly neither Virgo nor Anio Novus have a cross section corresponding with the views of modern science. With the exception mentioned, all the aqueducts have an approximately similar section without any regard to the quantity of water they had to discharge; they were all laid out with a variable but continuous falling gradient and were carried over the valleys on arches and through the mountains in tunnels, either with or without a lining of masonry, but all coated with hydraulic mortar. While the older aqueducts, such as Appia, Anio Vetus, and Marcia were mostly constructed of ashlar without mortar (except for the inner lining), the latter constructions show us examples of all the different descriptions of masonry I have already mentioned, and which are shown on plate. We might, therefore, be inclined to conclude that the Romans were not aware of the use of inverted siphons. This conclusion would be erroneous. The situation of Rome was so favorable, that it was an easy matter to bring the water down to a suitable point for distribution by a continuous gradient. I mentioned that the limestone group of springs was 250 metres above the highest point of the town. What a contrast to Paris; The springs of the new Vanne aqueduct are in fact a few feet *below* the top of the Montmarte hill, and we must not forget that inverted siphons, if such had been used to cross the wide depression near Roma Vecchi, must have been immensely long, would have been constantly exposed to all sorts of accidents from the dense population of the suburbs, and lastly that no doubt the founders of the different aqueducts were sufficiently desirous of perpetuating their names by the erection of great and imposing works near the city, and were unwilling to bury their money in the ground. Similar reasons induced the municipality of Vienna to give up the notion of inverted siphons, and to substitute for them long and lofty aqueducts in the construction of new water works. Views of both Viennese and Roman aqueducts are annexed. The saving by using pipes did not appear sufficient to justify their employment, and particularly to outweigh the disadvantages of a possible fracture and interruption of the whole supply. But if in many cases we even now justly prefer aqueducts to inverted siphons, although we have cast-iron pipes of any required thickness and strength at our disposal, how much more was such a preference justified in ancient Rome. For the Romans had nothing but lead pipes made of a pear shape by the two edges of a lead plate being brought together and soldered; these pipes were unable to resist even a very moderate pressure, and presented no guarantee whatever against frequent rupture and interruption in the supply. But two great examples of crossing valleys by means of inverted siphons prove beyond any doubt that the principle was well known to the Romans. They occur near Lugdunnum (Lyons) in France. The aqueduct here discharges into a chamber on one hillside, from which the water is let down the slope by nine lead pipes. These again divide into eighteen pipes, laid side by side, which cross the valley on a bridge 28 ft. wide, and about 160 ft. above the River Garon. This construction saved half the height, and about three-fifths of the length of the aqueduct, and appeared justified for a provincial town like Lyons at some distance from the city itself. We also find an inverted siphon laid under the bed of the Rhone near Arles to supply part of the town situated on an island; the pipes are 6 in. in diameter, and connected by soldered rings.

The Romans possessed three almost independent water services, for which they used water of different degrees of purity. The least clear and most loaded with sand, such as the Anio aqueducts supplied, was used for public baths and for watering the streets; the clearer water from Tepula and Alsietina served for tanks, fountains and washing troughs; while the very best (Virgo, Marcia, and Claudia) was confined to drinking purposes, and these springs were undefiled even after the heaviest rains. Their water was remarkably pure and the analysis of the springs made recently by Colonel Blumensthil, shows the water to have contained little more carbonate of lime and other impurities than that now supplied to Vienna by the springs of Kaiserbrunn and Stixenstein. Indeed we might expect a great similarity since the geological formation from which the springs rise is very similar to that of the Schnesberg, viz., dolomitic limestone. But the incrustations still remaining in the conduits show that it was somewhat harder.

As the Romans used three different sorts of water, the question naturally arises, whether they had three distinct services with mains, pipes, etc. In reality, however, they hardly possessed any proper service at all, at least none agreeing with our notions. The water of the aqueducts flowed through small "piscinæ," or tanks in which it deposited the heavier sand or gravel with which it was charged. It thus reached the Castella (water castles) or reservoirs near the city. They were of very moderate dimensions and did not serve at all as supply reservoirs, but were only meant to distribute the water to the numerous smaller cisterns or towers, which were scattered all over the city at different places. These were circular cisterns of masonry, in which it appears the water was intended always to remain at a certain level. Twelve inches under this theoretical line were the outlets of all the different pipes, mostly set vertically, and the larger of which supplied the baths and bublic institutions, while each of the smaller ones supplied one house, and one only, so that every private person who wished to have the water laid on had to lay a pipe from the nearest tower all the way to his house. When we remember that the Romans used often to take up two hundred yards of road to supply one house, we shall not be so inclined to grumble at the occasional interruptions which now occur in the street pavements to connect a main with a private dwelling.

(*To be continued.*)

Civil Engineers' Club of the Northwest.

CHICAGO, Sept. 26th, 1876.

The October meeting will be held at the Sherman House Club Rooms, at 4 P. M., Tuesday, October 3d.

Paper for the evening, "*A French Railway Charter*," by Chas. Paine. Members who have not as yet acknowledged receipt of Vol. 1 are requested to send notice of its receipt to the Secretary.

L. P. MOREHOUSE, Sec.

WHAT TO SEE AT THE CENTENNIAL EXHIBITION.

HENDERSON, Ky., Sept. 12, 1876.

Editor Engineering News:—Doubtless like many others of your readers, I will visit Philadelphia this or the next month, and to know before hand what to see and where to see it, will save much time, and otherwise be very acceptable information. If you will give in your next paper or the one after the next, the points and objects of most interest at the Centennial to an engineer, and also where they are to be found, you will confer a favor. GASTON M. ALVES, Engineer.

The visitor, on first arriving at the Centennial Exhibition, naturally desires to obtain a knowledge of the relative situation of the various buildings. He can readily do so by taking a round trip upon the cars of the narrow gauge railroad, which, starting from the east end of the main building, will bring him back to that point in about twenty minutes, after a ride of four miles. From this rapid survey and an inspection of the plan in the guide-book he will gain an acquaintance with the lay of the land. The grades and curvatures of this line and the engines furnished to work it by different firms, can be inspected at a later time. Some electric signal apparatus will be found in actual use at one or two points.

If the Main Building is first taken in hand, our engineering friends will be very likely to make an early call at the room of the American Society of Civil Engineers, in the West Gallery, that end of the building nearest to Machinery Hall. Here he can register his name and city address for the information of his brethren. The exhibit in these rooms consists of models, photographs, drawings and tracings, many of which latter sheets could not be displayed for want of space, but which may be examined by those inte ested in them.

Upon descending to the ground floor, and passing along the southerly side of the building, after walking through China and Japan, one comes to the drawings, pupils' work and models from the technical schools of Sweden; next to the Art and Industry Museum of Moscow and the contributations from Stroganoff's Central School of Technical Drawings, in Russia. After passing through the German department one will find near the centre aisle the electric signals for working a railroad, exhibited by the Electric R. R. Signal Co., of N. Y. Just beyond the middle entrance on the south side of the building is a collection of specimens showing the work of dry-rot and of the *teredo navalis* upon timber, and the preservative effect of creosote (coal tar oil). This exhibit is by Page, Kidder & Fletcher, New York. The south gallery, at this entrance, is occupied by educational exhibits, and here may be found the Drawings from the Thayer Engineering School of Dartmouth College and those from the Engineering Department of the University of Michigan.

Close at hand the Fire Proof Building Co., of New York, have erected a small model in cement concrete, with fire-proof floors, etc., and introducing perforated tiles. A large model of the Lucy furnace, by Carnegie, Bros. & Co., Pittsburgh, is found a short distance beyond, and then a large collection of iron and steel shapes and forging from the mills of this firm, from the Edgar Thompson Steel Co., and others, will be met with. More on the left, the Stevens Institnte of Technology have brought together a collection of models, drawings, apparatus of instruction and research, Thurston's Autographic Recording Testing Machine, etc. In the neighborhood, but a little more to the left, will be found the exhibits of engineering field instruments by various firms, which have lately been described in detail in the NEWS.

Passing back toward the iron and steel exhibits, the visitor will find some photographs of bridges and a model of part of a bridge, illustrating the patented style of construction of F. C. Lowthorp, C. E., of Trenton, N. J. The Kingston Bridge Co's. exhibit will also be met with. It includes a large working model of the Raritan Bay Pivot Bridge, 472 ft. span, view of Ohio river bridge, tube of steel staves and connections for St. Louis Arch Bridge, rivetless column, and wrought iron weldless link. Just outside of the main building at this point, between it and the mineral annex, may be seen the 120 ft. steel rail, 62 lbs. to the yard; a 60 ft. do. 58 lbs. to the yard and twisted cold, with some other products of the Edgar Thomson Steel Co., as also a 9 in. I beam, 80 ft. long, a 15 in. do. 52 ft. long, and angle irons of 52 ft. and 55 ft. from the Union Iron Co., of Buffalo, N. Y.

There is little else of engineering interest upon this side of the Main Building. The east gallery is occupied by the Massachusetts Educational Exhibit, and here will be found photographs, drawings, designs, theses and models from the Mass. Institute of Technology, the Lowell Department of Industrial Design, and the Worcester Free Institute. This latter school has contributed some specimens of the students mechanical work in the shop.

Taking next the northerly side of this building, one presently encounters the display of the Netherlands, where in the portion contiguous to the main aisle, is found fine models and illustrations of their extensive works in hydraulic engineering, drainage and the reclamation of large tracts from the sea. A considerable time can well be spent here. The Swiss show the profile of the St. Gothard Tunnel, the plan of the line, and its progress, The approaches to this tunnel were laid out with much difficulty.

The portion assigned to Great Britian is beyond the principal transverse aisle, and here may be seen specimens of the maps of the Ordnance Survey, or various scales, and also some Geological Maps. As the end of the building is approached one will see the collection of iron and steel rails and shapes from the Motala Works, the Fagerata Steel Works, and others of Sweden. The Sandvik Iron Works show some large Bessemer steel forgings.

While making even a hurried survey, the visitor is likely to see many other objects which arrest his attention and excite his interest. What he will most enjoy inspecting depends upon his specialty. The large collections of minerals and iron ores, in the southeastern portion of the Main building, as well as in the mineral annexe near by, have not been alluded to, and will at tract mining engineers. In the principal annexe, No. 106, on the northerly side, may be found some models of railroad cars, etc.

It is hardly worth while to attempt to recapitulate the objects of interest in Machinery Hall, as nearly every one will feel obliged to make a thorough inspection here; Krupp's exhibit, the various fire and drainage pumps at work in the hydraulic annex, the rock drills, the diamond rock boring machine, Wm. Sellers & Cos. display of machine tools, the Corliss engine, the various types of stationary engines, both large and small, some admirable and some ingenious, the traction engines, the locomotives, the Westinghouse brake apparatus, the system of switches, signals, and levers, the ponderous tools for sinking and tubing shafts, the displays of pipes, valves, and hydrants; these and many others will call for careful study. All types of boilers may be seen at work in the boiler-houses to the south of Machinery Hall, but about as much satisfaction can be derived from looking at the brickwork which encases a boiler and hides it from view, as from inspecting the outer casing of a turbine wheel.

The Russian exhibition, in Machinery Hall, of the work done by the pupils in her school of practical mechanism is well worth examination. It seems to be much in advance of anything which has been done in this country. Samples in forging, turning, planing, filing, and fitting, are shown, with the sets of tools used in each branch of iron working. The specimens are a proof of great proficiency in the pupils. Cornell also exhibits in Machinery Hall some machine shop work, especially some true planes in iron. The American Bridge Co. have a beautiful model of the stiffened suspension bridge now being erected by them at Pittsburg, and recently illustrated in the NEWS.

Outside of Machinery Hall, near the west corner, will be found the gunpowder pile-driver, and apparatus for conveying loads, or discharging vessels, and a peculiar pneumatic tube. One of the original locomotives, an ancient and honored relic, also an old car, and a piece of stone ballasted, standard track of the Pennsylvania R. R. are near by.

France has erected a building of red and black bricks, between Memorial Hall and the Vienna Bakery, at the easterly end of the grounds, for her department of Public Works. Here may be seen the finest collection of models, to a large scale, photographs, and views, illustrating her bridges, railways, dams, etc, to be found on the grounds, and a careful study of this exhibit cannot fail to be very satisfactory to all engineers.

The United States government building contains much of interest. Here are placed models from the Patent Office, almost without number; gun and cartridge machinery are shown in operation; models of all the different arms are ranged on the walls; the light-house department is fully illustrated; the engineer operations at different points are shown by models and drawings; the pontoon train and the field telegraph are just outside of the building.

Agricultural Hall will not detain the engineer long, except as he is interested in things outside of his profession. If he cares for windmills he can find a number at work to the eastward of Agricultural Hall, in the extreme eastern corner of the grounds. On leaving Agricultural Hall at the southerly end he will have an excellent opportunity to look at and take a trip on the one-rail Elevated Railway which here extends across a ravine. This is the system which is said to be recommended for Brooklyn,

The Worthington Duplex Pumping Engine which supplies the Exhibition may be found on the bank of the Schuylkill at the foot of Lansdowne Ravine and outside of the grounds. The three large engines of the same kind which supply West Philadelphia are about half a mile further up the river.

The bridges over the Schuylkill are well worth inspection. They are of many types, from the beautiful iron arches of the Chestnut street bridges to the old-fashioned wooden Howe Truss. Girard Avenue Bridge and the one below at the Fairmount Waterworks are well known, from the frequent mention which have been made of them. The bridge on 40th st., over the Pennsylvania R. R., should also be examined, as a good style of stiffened suspension.

Enough has been said to give some imperfect idea of what is to be seen, and a map and plan in a guide book will readily give the information how to find the desired points. How much more one sees depends upon the person and the time at his disposal. Philadelphia contains much of interest, and a stranger can readily find his way over the city.

THE OIL LINE TO THE SEABOARD.

The Pennsylvania Transportation Company has, as is well known, obtained a charter to build a pipe line from the oil regions to the seaboard within the Commonwealth of Pennsylvania. The eastern terminus of this line is, we understand, to be at Chester, Pa., and arrangements are now being made with the Philadelphia and Reading Railway to carry the oil from the terminus to New York. A branch is also to be made to Baltimore. The right of way is now practically obtained to both Philadelphia and Baltimore, it being given by most of the farmers and land owners along the route, they regarding it as rather a benefit than otherwise.

The pipe is of four inch internal diameter and it is expected that it will take six thousand barrels per day from railroad freights. All the needed pipe, boilers and machinery for forcing the oil is already contracted for and is to be furnished at the rate of three miles a day beginning last week. The company expect to lay 300 miles in 100 days and have already broken ground at Brady's Bend, Butler County, amid great jollification. The pipe is to be sunk 30 inches under ground, beyond the reach of the plow, and is to be carried over mountains, across bridges and down valleys.

There are probably 4000 miles of pipe already laid in the oil regions, which will in the main become tributary to this trunk line, and as this seems the cheapest and most natural way of transporting the oil the railway companies are necessarily alarmed at what promises to deprive them of a large branch of lucrative freight traffic.

It will be recollected that three years since the Columbia Conduit Company built a three inch line from the oil regions to Pittsburgh. When this line was under construction the West Pennsylvania Railway Company obtained a decision from a county judge to the effect

that "fee simple" means posession from the centre of the earth to the sky, and that the railway company could refuse to let the pipe company across the railway, under or over the track. So the pipe company carried their pipe up to each side of the track and carried their oil over in tank wagons.

The Pennsylvania Railway Companies took the alarm even before the pipe laying had commenced and at their request the attorney general of the State has issued a writ of quo warranto, upon which the courts can issne an injunction to prevent the construction of the line.

The question will undoubtedly be carried into the courts until it is finally adjudicated in the highest court. This will involve long and vexatious delays, as the interests at stake are large and the railway companies will not give up without a hard fight. The question too is essentially new, with no authoritative and governing precedent, and for that reason, one to be carefully and slowly considered by the courts.

To the non-legal mind the question seems simple and readily decided in favor of the pipe line. It would seem as if the question was quite similar to the right of one railway to cross another or the right to stretch telegraph wires over a track, build a bridge over it, or lay water and gas pipes under it. True, in most of these cases, the objects which cross over or under the track are part of interests, originated or in use before the railway period, and having to a certain extent a prior claim. and in most cases do not conflict with railway interests.

It would not seem that, because a thing is comparatively new, useful, cheap, though in conflict with vested interests in that it promises to supplant them in a measure, it does not, for that reason, have any rights which said interests are bound to respect. We believe it has been the history of all inventions and improvements on former methods, that their projectors have been heaped with calumny and the improvement itself opposed with all the bitterness which old interests, especially those of a financial character, could muster.

This is not so true as formerly when innovations on old methods were frequently met with mob violence. In the present time the innovations are met through a more refined method, viz., the machinery of the courts. We believe, however, that all such innovations of positive merit, involving a revolution in methods, have finally succeeded, while no doubt many new and useful improvements have been, at least for the time being, "squelched" by interested manufacturers until a later and more tolerant age allowed of their recusitation in some "original invention."

There is no doubt but that the oil line to the seaboard will become a fact after much litigation, in which the rights of such corporations will be defined. But it seems a queer civilization that should jump upon and kick enterprises in their infancy for no other reason than that they are in their infancy and therefore new. It too much resembles some of the beasts of the field which gore their young.

SCARCELY had the official trials of the "Woolwich Infant" (81 ton) been completed ere Sir William Armsfrong received orders from the Italian government for eight 100-ton guns. The largest made at the Elswick works was but 30 tons, and the receipt of this order necessitated many new arrangements and extensions of the plant. One of these guns was completed in June last, and others will soon follow. They are intended for the armament of the Drillo and the Dandola, the two most recent and powerful additions to the Italian navy. These guns are built on the coil principle first used, we believe, by Sir Wm. Armstrong. The steel tube is 31 ft. 3 in. long, and has a thickness of six inches at the powder chamber tapering to 3½ in. at the muzzle. The bore is 30 ft. 6 in. in length, and 17 in. in diameter. The coils or wrought iron cylinders are ten in number. For a length of 13 ft. from the rear end of the gun the steel tube is surrounded by a coil 7 in. in thickness. Outside of this for a length of 9½ ft., is a second coil 8 in. thick and beyond this again is the 11 in. trunnion coil for a space of 2 ft., and still further a tapered coil 3 ft. 3 in. long and 6½ in. average thickness. Immediately back of the trunnion coil for a length of 5½ ft. a 9 in. coil is placed about the rear of the gun. The four single coils commence midway of the gun and terminate at the muzzle, tapering from 10 in. to 2½ in. All the coils interlock and overlap each other to a greater or less extent. The extreme length of the gun is 32 ft. 10½ in. The greatest diameter of the breech is 6 ft. 5 in., and at the trunnion coil 5 ft. 4½ in. The diameter at the joint where the single coil commences is 3 ft. 9 in. and at the muzzle 2 ft. 5 in. The twist of the rifling is a uniformly increasing spiral terminating at the muzzle in one turn in 50 calibres. The form of the rifling is the polygon, recently introduced for heavy muzzle loaders by Sir Wm. Armstrong. The projectiles are not studded but each has a copper ring or gas check fixed to its base, which approximately fits the rifling and is expanded by the explosion to accurately fit the grooves. This serves the double purpose of a gas check and of centering the projectile while in front the windage is reduced by a copper band 2 in. broad. The weight of the proof projectile will be 2500 lbs. and of the service shell 2000 lbs. The powder will be ignited at the centre of the cartridges. The charge will probably consist of about 400 lbs. of 1½ in. cubes. The 100-ton gun will be mounted on a special carriage fitted with hydraulic gear for maneuvering and taking up the recoil. Loading and sponging will also be done by hydraulic agency. It is expected that the gun will give a duty in practice of 300,000 foot tons.

WE ARE gratified to learn that Mr. S. W. Burnham has been appointed Director of the Dearborn Observatory by the Chicago Astronomical Society, Prof. Safford, the late director, having accepted the chair of Astronomy in Williams College. Mr. Burnham is not so fully appreciated here as in foreign countries, where his investigation of double stars has secured him an enviable reputation and a membership in the Royal Astronomical Society of London, and in the German Royal Society, at Berlin. He is at present engaged in preparing a general catalogue of the double stars, which is to be published by the National Observatory at Washington. This work is now well on towards completion. Mr. Burnham's observations have been chiefly conducted with his own six-inch refractor, but when he once has the splendid eighteen-inch refractor of the Dearborn Observatory under his control, we may expect many new contributions to Astronomical science. Mr. Elias Colbert has been acting Director for the past three years and has done much in raising money and putting the observatory and instrument into working condition. It is to be hoped that members of the Astronomical Society, many of whom are very wealthy men, will not allow the Observatory, and those connected therewith, to suffer from lack of funds.

PROGRESS AT THE JETTIES.

We are pleased to acknowledge the receipt of a fine tracing (scale 1-2400) of a map of South Pass, giving the soundings taken on Sept. 11 and 12, with the 20, 22, and 24 foot contours, all referred to average flood tide.

We have carefully scaled the map and compared the results with the table given in Mr. Corthell's paper printed in our issue of Sept. 2. The result on the whole is gratifying and shows a great improvement in the channel since August. It is evident that the channel is becoming much more regular both in depth and width, the shallow portions being scoured away and many of the deep portions being reduced. The shallowest place within the jetties is just above the head of the west jetty between stations 30 and 35, where the distance between the 22 ft. contours is about 370 ft.

This shoal however carries 21 ft. of water. Out between the ends of the jetties the 18 ft. channel is everywhere over 500 ft. wide, the 20 ft. channel 180 ft. wide, and the 22 ft., 50 ft. wide.

The least depth on the crest of the bar in the line of deepest water is 22.2 feet. The 24 ft. contour or channel is quite well developed also. The following is the distance betwen the 24 ft. contours in the line of deepest water. Between Station 20 and 60, 1720 ft.; opposite 84, 90 ft.; between 113 and 118, 440 ft.; beyond 120, 220 ft.

The following figures giving the depths in line of deepest water the reader will be interested in comparing with table III of the article of Sept. 2d.:

East Point, 33.7 ft.; Sta. 10, 28.5; 20, 25.0; 30, 23.0; 35, 22.0; 40, 37.7; 45, 27.6; 50, 26.3; 55, 28.0; 60, 28.5; 66, 29.0; 70, 25.0; 75, 25.9; 80, 26.9; 85, 27.9; 90, 28.8; 95, 27.5; 99, 31.3; 105, 33.0; 110, 27.0; 115, 23.3; 117, 22.3; 119, 27.3; 120, 26.1; 124, 22.2.

The following figures give the width of the 20 ft. channel: East Point, 560 ft.; Sta. 12, 460; 22, 500; 30, 470; 35, 380; 40, 425; 45, 350; 50, 230; 55, 460; 60, 400; 66, 355; 71¼, 335; 76, 350; 80, 325; 85, 385; 90, 550; 93, 380; 99, 360; 105, 440; 110, 450; 115, 405; 118, 180; 121, ∞. (Compare with Tab IV)

The 22 ft. channel averages from 30 to 70 ft. less width than the 20 ft. channel, and is interrupted in one place only.

We are glad to learn that the steamer New Orleans turned back from South Pass on Sept. 2d, not from lack of water between the jetties, but because of the shoal at the head, it being inconvenient for her to turn around after she had once gone into the pass owing to its narrowness. Ample water existed between the jetties at the time. The works at the head of the pass are progressing, we believe, satisfactorily.

HELL GATE.

The great obstruction to ship navigation between New York and the Atlantic via Long Island Sound was successfully blown up on last Sunday, the 24 inst., at 2 51 p. m. A dull "thud" was heard, two quick, short pulsations were felt in the ground beneath, in a straight and narrow line from north to south of about 300 yards length, the water whitened and rose evenly three or four feet, then broke and spurted up about twelve feet high, in irregular, dark yellowish masses mixed with smoke, and fell back, and in a moment the river resumed its usual aspect. The work was done. The great crowds which had gathered in every available looking place sent up a cheer and the boats set out to pass over the place so recently a dangerous reef. The crowds went home, some simple ones disappointed that no buildings were shaken down, no glass broken and no tidal wave to sweep thousands from the docks, others to moralize on the moral turpitude of Gen. Newton in making a gala day of the Sabbath, evidently thinking with Wm. E. Dodge and some other good and well meaning citizens of New York that the success of an enterprise involving such a great expenditure of money and engineering ability, should be jeopardised by an unwarranted delay.

The work seems to have been well done and the reef thoroughly broken up. Unofficial soundings, taken on Monday, give a least depth of 12 feet, and when the debris is removed a clear channel will exist over the site of the reef of 26 feet at low water. The tidal run is much improved in the absence of the dangerous eddies formerly existing on the western side of this reef.

The narrow channel now called Hell Gate (originally Whorl Gate and afterwards Hurl Gate) is off the northwest corner of Long Island, in a formation of stratified gneiss. This channel is quite tortuous, in many places being obstructed and rendered dangerous by sharp isolated rocks in the channel way and submerged reefs making out from the shores. All these causes deflect and alter the tidal current, which here has a rapid run owing to the narrowness of the waterway, producing dangerous eddies or whorls, which apart from the submerged rocks, are quite dangerous to vessels, often throwing them powerless on the rocks.

The position of Hallett's Point reef and other rocks of the channel, the depth of water, etc., and also the direction of the flood and ebb tides and the location of the whorls or eddies is well shown on the large map. The position of Hell Gate in reference to New York harbor, East river and the Sound, is shown on the general map, to a scale of 1-80,000. The map extends as far east as Throgs Neck at which the East river proper, or the strait of that name, may be said to terminate, and the broad expanse of the Sound to commence.

The small map shows the route pursued by ocean steamers by way of Sandy Hook and also the route by way of Hell Gate and the Sound, which no doubt will come rapidly into use for ocean traffic as soon as the improvement is completed, and it may one day be the main outlet to New York harbor. At the present an extensive coast trade is carried on by way of the Sound between New York and the New England cities, and it is also the route of the magnificent lines of boats which run to Stonington, Providence and Fall River.

Probably the extent of the coasting and Sound trade alone would warrant the radical improvement of Hell Gate. Home bound vessels can easily make the comparatively quiet waters of the Sound via Montauk Point, when the prevalence of severe weather would cause much delay in beating off Sandy Hook. It is also

claimed that there will be a saving of fourteen hours of time together with pilotage dues and other expenses in favor of the Hell Gate passage for outward bound vessels. All these considerations together with the great advantage in a military point of view, in having two available outlets to the great port ot New York in case of a foreign blockade, would certainly warrant the radical improvement of Hell Gate, of which the works so successfully prosecuted thus far are really but a small part.

There is, however, a more vital consideration. Forces are at work which at no distant day might practically close the port of New York to deep draught vessels and thus jeopardize its foreign commerce. It is well known that Sandy Hook has advanced northward about a mile in less than a century, partially across the main ship channel which at the period of the earliest coast survey at this point, carried 120 feet of water. In this channel at present there is but 23 feet of water at low tide, the other channels carrying somewhat less. What is to be the ultimate fate of this entrance it is of course impossible to say, but it is more than likely that the forces have reached or will soon reach a condition of equilibrium in which the channel will be maintained in practically a permanent condition. If there is still a tendency to shoal, it probably can be corrected by artificial constructions. But when such interests are at stake as the commerce of New York, every contingency must be considered and amply provided for. So this consideration above all others would warrant the improvement of the East river or Sound entrance and probably is the mainspring in urging it forward in our present depressed financial condition.

In 1848, Lieutenant Porter and Davis first recommended the improvement of the Hell Gate by the blasting and scattering of Pot Rock, the Frying Pan and Way's Reef. A part of the reef at Hallett's Point was also recommended by Porter. In 1852 Congress made an appropriation of $20,000 and $18,000 was expended on Pot Rock in surface blasting (or the Maillefert process), by which the depth on the rock was increased from 18.3 to 20.6 feet.

Nothing farther was accomplished up to 1868. In 1867 Gen. Newton made an examination and report, and in accordance therewith, appropriations were made and work commenced. For operation on the channel rocks a drilling scow was constructed having a well-hole 32 feet in diameter, through which 21 drills were worked while the scow lay on the surface of the water over the rock. In 1869 this machine operated on Diamond Reef drilling holes of 7 to 13 feet depth in which 30 to 35 lb. charges of nitro-glycerine were exploded. Coenties Reef was attacked in 1871, 93 holes being drilled, charged with nitro-glycerine and exploded together with 17 surface blasts. In 1872, 17 holes were drilled and 11 surface blasts made on Frying Pan Rock. In 1873, 307 holes were drilled and 39 surface blasts made. In all 17,127 lbs. of nitro-glycerine were used on the channel rocks, which were removed so as to give 25 feet depth at low water. The work on the channel rocks is by no means complete.

In 1869 operations were seriously commenced on the Hallett's Point Reef. A coffer-dam was built of heavy timber, fastened to the rock by bolts. The cofter-dam was pumped out and the shaft sunk to 33 feet depth. Ten headings radiated from this shaft or well which were intersected by numerous cross-galleries until the whole rock out to the 26 foot contour was honeycombed. The plan of these headings and galleries and also the coffer-dam are so well shown on the engraving that no further description seems necessary. The width of the headings was about 14 feet and their height varied from 22 feet at the shaft to 7 feet at the end. The floor of the mine falls gradually, the roof of the excavation more rapidly, following the bed of the river above, and keeping up an average thickness of the roof of about 10 feet.

The length of the tunnels varied from 185 to 300 ft., the average being 270 ft. The aggregate length of tunnels and galleries was 7,426 ft.—4,857 ft. of tunnels, and 2,568 ft. of galleries. 173 piers about ten ft. square were left to support the roof. The area of the reef above the 26 ft. line was about three acres, 2¾ of which was undermined. The detailed survey of 1871 gave the cubic contents of the rock above the 26 ft. contour at low water, as 51,000 cu. yds. 47,461 cu. yds. was removed in the excavation, much of which was below the 26 ft. contour. The work was first prosecuted by hand drilling, but subsequently the Diamond drill and Burleigh drill were both used. The Burleigh drill was used almost exclusively during the latter period of the excation, the fine quartz veins dislodging the diamonds of the Diamond drill from their support, rendering them inefficient. The excavation was completed in June, 1876, seven years after its commencement. The work was much delayed through inadequate yearly appropriations.

After the completion of the excavation 3,676 holes were drilled in the pillars and roof, for the reception of the cartridges, these holes being from 2 to 3 in. in diameter and averaging about 9 ft. in length. The explosives were purposely divided into this great number of charges in order to diminish as much as possible the vibration in the ledge which extended under a part of Upper New York. Each hole was numbered and its charge was proportioned to the work required at that point. The cartridges were about 3 in. in diameter and from 9 in. to 24 in. in length, one or more cartridges being inserted into each hole according to the previous calculation.

The quantity of explosives contracted for was:

Rend-rock	9,061½ lbs.
Vulcan powder	14,244 "
Dynamite	25,976 "
Dynamite (in primers)	3,500 "
Total.	52,781½

Deducting 5,000 lbs. returned to the contractor, leaves 47,781½ lbs. or equivalent to between 300,000 and 350,000 lbs. of gunpowder. All these explosives are mixtures of nitro-glycerine with some foreign substance, which is supposed to render them safer in handling. These compounds however have only from 50 to 75 per cent. the strength of the pure nitro-glycerine. This is probably the most powerful charge ever exploded, the next in size being the Blossom Rock blast, in San Francisco Bay, in which 45,000 lbs. of powder was used.

The charges are arranged in what are termed battery groups, there being 184 of these groups of 20 charges each. The priming fuse is the ordinary electric fulminate of mercury exploder. The wires of a group were connected each to each. A short distance from the mine a strong bomb-proof was built in which the batteries were placed. These batteries consisted of 960 bichromate of potash cells, the zinc and carbon plates opposing an area of 40 sq. in. each to the fluid. These cells were divided into 23 batteries of about 42 cells each connected for intensity. Each battery exploded 8 groups of holes or 160 fuses in continuous circuit. The wires from the batteries to the charges were insulated by a gutta percha coating, and placed in wooden boxes to prevent abrasion.

The circuit closer consisted of 23 brass pins which were to drop simultaneously into 23 mercury cups, thus closing each battery circuit at the same instant. The plate containing the brass pins was held by a fuse or torpedo, which was exploded by a separate battery situated at a safe distance. This circuit was finally closed by Gen. Newton's little three year old daughter.

It may be well to add that some detached masses of water and rock were thrown to a hight of 75 feet, and that after the explosion the space over the rock was filled with yellowish muddy water which was soon swept away by the tide. Previous to the explosion the mine was filled with water, and the explosion itself took place at high tide, in order to get the resistance due to the water tamping, thus confining the energy of the explosives to their proper mission, that of breaking up the rock. Gen. Abbott had placed observers at various points in the vicinity with proper appliances to detect any vibration or jar in the earth. The jar was thus detected at a distance of 10 to 13 miles, more particularly along the Hell Gate formation. No damage was done however, even to the nearest buiklings.

Congress has appropriated for the entire Hell Gate improvement $1,940,000, of which $1,686,841.45 have been expended up to Aug. 1, leaving a balance which will be needed in part for removing the debris of the late explosion.

The estimated cost of completing the entire work of improving Hell Gate and the East River is $5,139,120.

The present channel between Flood Rock and Hallett's Point is 600 ft. wide. Flood Rock will probably be the next scene of mining operations, the work to be done here exceeding in extent that required at Hallett's Point. The removal of Flood Rock will widen the channel to 1,200 ft., or nearly the same as that beneath Brooklyn Bridge. Diamond Reef has but 19 ft. of water and will have to be deepened. No appopriation of sufficient amount is available for beginning these works and they may consequently be delayed for some time. Although the currents are much improved by the removal of the present obstruction, the full benefit will not result until the removal of the extension reef known as Flood Rock.

The splendid success of this explosion is an additional demonstration of the accuracy with which science can weigh forces, and direct and proportion them to the work to be accomplished, and is a fitting tribute to the engineer through whom this application of scientific truths are made.

It is only after careful experiment and thought that such results can be reached, and the removal of Hallet's Point Reef was a problem, not a whit more difficult than many that occur in the practice of the profession, although from its novelty and the popular superstitions regarding explosives, it has attracted wide spread attention.

It is a fitting season to remind the non-scientific of the careful weighing of forces, and study of materials which every engineer has to understand in the pursuit of his profession, and of the usually happy result of his calculations. But often these experiments are too extensive for private or corporate enterprise to undertake, and from the conflicting interests involved can only be adequately conducted under government patronage.

Such are the experiments now being conducted in regard to the properties of metals by a board appointed at the instance of the American Society of Civil Engineers. The benefits to accrue from a proper knowledge of the properties of materials are too numerous to enumerate here, but the object to be reached should awaken more than at most a luke warm interest among the people, and the Congressional appropriation should be made not grudgingly, nor should it involve the necessity of lobbying.—[The map referred to in the preceding article was unavoidably delayed but will be published next week.

NOTES.

The stand-pipe of the new West side pumping works of this city will be finished next week.

A portion of the works of the Joseph H. Brown Iron Company, of South Chicago, have started up.

The pressure of the water in the pipes leading from the artesian well at Hennepin, Ill., has been ascertained to be 32 pounds per square inch.

The claims of the private stockholders, $486,299.77, having been satisfied, the New York and Brooklyn Bridge is now the property of the two cities.

Mr Meiggs, of Peruvian railroad celebrity, is negotiating with the Nicaraguan Government for the contract to build the Nicaraguan inter-oceanic ship canal, so it is reported.

A New Orleans man has invented a safe for use on board vessels, which in reality is a buoy not liable to be sunk or permanently lost, provided with compartments for bullion, etc.

A heavy four-wire cable has been successfully laid across the Strait of Canso, giving the Western Union Telegraph Company and Anglo Cable Company three cables at that crossing.

The great Eldorado ditch, in eastern Oregon, is finally completed and furnishes water to quite an extensive amount of placer mines. The ditch is nearly 80 miles long, and has cost $500,000.

According to the report of the Coast Survey, California has 1,136 miles of coast line, 272 miles of island shore, and 240 miles of tide water river shore, making altogether 1,648 miles of shore line.

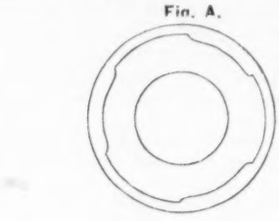
A petition has been handed to the Park Commissioners of Boston, to locate the park on the Mill Pond Flats. It was stated that this proposed park would contain 3,250,000 sq. ft., and that the land which was owned principally by the Eastern Railway could be bought and graded for $1,000,000. It would also be of great benefit to adjoining land, so much so that the owners would be willing to pay betterments. It would also be more convenient than the Ten Hill Farm. The matter will probably be referred to the City Council.

Improvement in Surveying Instruments.

The improvement consists in a new arrange ment affording a more convenient, rapid and safe attachment and detachment of the instrument to and from its tripod than any other device so far employed.

On the tripod head, instead of the ordinary screw, there are three projections, the lower faces of which incline in the manner of a screw. These projections are at the same height from the shoulder of the plate, and are one-sixth of the periphery in length, thus leaving between them a space of the same size. The base plate of the instrument has on its inner side three similar projections, and also the same number of spaces. The connection of the two is done by letting the projections of the base plate pass through the spaces of the tripod head, when a slight turn to the left will effectually join the instrument to the tripod. The accompanying cuts clearly show the construction of the new arrangement.

Fig. A.



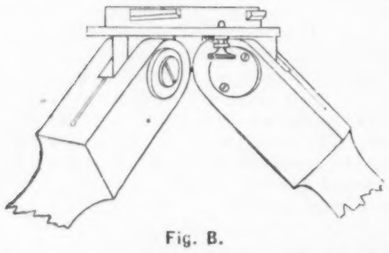


Fig. B.

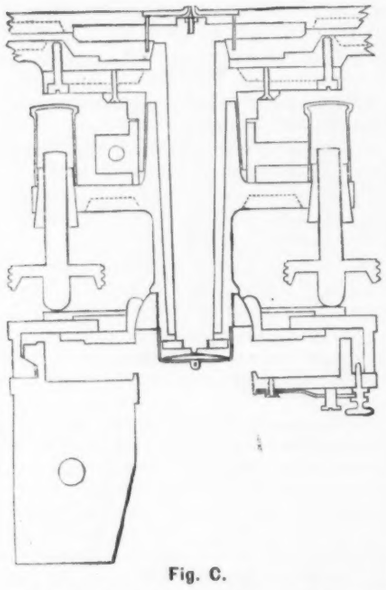


Fig. C.

Fig. A is a plan of the base plate of the instrument. Fig. B is an elevation of the tripod head. Fig. C is a sectional cut of the lower part of a Transit. The little knob which is seen underneath the tripod head in Fig's. B and C is attached to a spring catch, which is designed to prevent the falling off of the instrument from the tripod when carried on the shoulder, in case of neglect to properly fasten it.

The advantages of this arrangement will be better understood after examining the present employed methods of attaching instruments. Transits are now generally connected to the tripod by means of a screw at the base plate. To attach an instrument by this method is very tedious and unsafe; sometimes the screw does not catch and the instrument is liable to tip over. To avoid this a good many instruments detach above the leveling screws in the centre, which, however, is very defective. It is almost impossible to keep the centre clean; a little dirt will often cause it to move very hard, and sometimes it will fret. Some instruments are made detachable above the leveling screws in such a manner as to always keep both centres covered and remaining with the instrument proper, requiring however an intermediate piece between the leveling screw plate and the centres, which adds unnecessary weight. In both constructions the plates have to be brought too high above the leveling screws and therefore cause unsteadiness.

The same reason which led to taking apart the Transit above the leveling screws, viz: "The unsafety and inconvenience of attaching and detaching," also caused the different methods of taking apart Levels. While some are constructed so as to leave the centre on the instrument proper others allow it to remain in the parallel plate. The latter method is the more defective of the two, because it throws the wyes out of adjustment every time the least dirt settles on either the socket or the cone, and because the bar and wyes have been brought too high above the leveling screws. Both constructions have one common defect. The cone and the socket have to be brought together tight to make the instrument steady, and in order to take it off again, it generally requires a sudden shock, which, of course, is liable to throw out the adjustments.

From the above it will be seen, that dividing an instrument in two parts is always injurious to accuracy, stability, etc., and that the new arrangement, which remedies all these defects, is a decided improvement. It is made by Messrs. Nickel & Strassberger, the well known engineering instrument makers, 128 Clark street, Chicago, who have applied for a patent.

On Estimating the Illuminating Power of Coal Gas.

BY WILLIAM SUGG, Assoc. Inst. C. E.

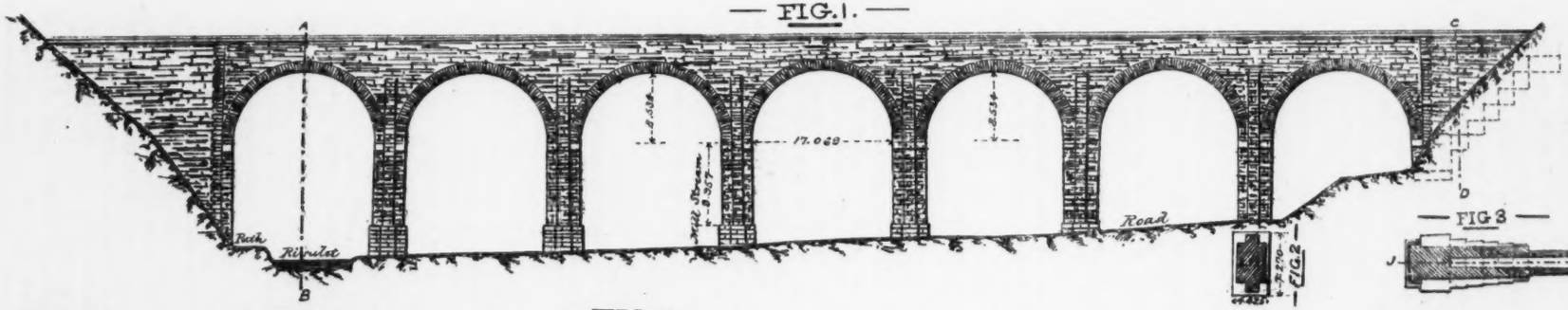
[A paper read before the Institution of Civil Engineers.]

(*Continued from page* 310.)

Mr. Sugg said since the Paper was written, he had combined the whole of its recommendations in an instru ment, in which the dial was divided off so as to show the quantity of gas required to give a light equal to any number of sperm candles up to sixteen. A burner was fixed to it which, when the flame was exactly at the height of 3 inches, gave always a light equal to sixteen sperm candles. The quantity of gas required to produce light of that intensity would vary according to the quality of the gas, and was shown in the tables.

Dr. Letheby remarked, through the Secretary, that Mr. Sugg had done good service by bringing this important subject before the Institution, with a view to discussion; for it must be admitted that the present means and parliamentary provisions, for estimating the illuminating power of coal gas were, as Mr. Sugg said, in an unsatisfactory condition. He might add, indeed, that this was not only the experience of practical men like Mr. Sugg, and the gas-testers appointed under various Acts of Parliament, but it was also seen in the difficulties and disputes which were constantly arising whenever gas companies and local authorities were in conflict, as was too often the case, on the question of the illuminating power of gas supplied to the public. These difficulties began about the year 1848 or 1849, when at the instance of three distinguished chemists who had passed away, namely, Professor Graham, Dr. Leeson, and Mr. Cooper, the Great Central Gas Consumers' Company adopted, under severe obligations, a parliamentary standard of illuminating power of twelve wax candles of six to the pound, each consuming 120 grains of wax per hour, and the gas was to be burnt at the rate of 5 cubic feet an hour from an Argand burner of fifteen holes and a 7-inch chimney. It happened that he was the officer appointed by the Corporation of London in 1850, under the provision of the Great Central Companies Act, which had just become law, to test the quality of the gas supplied to the city, and to see that the obligations of the company were duly fulfilled. This was the first appointment of the kind that was ever made; and he soon found that all the provisions of the Act for estimating the illuminating power of the gas were radically unsound and unreliable; in fact, the whole subject of gas photometry was in a crude and imperfect condition, and he felt that it must be reformed from end to end. The wax candles, for example, prescribed by the Act. were among the worst sort of candles that could be used for photometrical purposes; and the reason was obvious, for as a wax candle, like a common tallow candle, required snuffing, and grew dimmer and dimmer as the heap of carbon accumulated upon the wick, it was a difficult question to decide when that delicate operation of snuffing should be performed. One of the first thing, therefore, which he did was to rectify the standard candle; and after about one thousand experiments for the purpose of determining the relative illuminatiug power of wax and sperm, he adopted the latter, using a plaited wick which snuffed itself. This had been the standard candle from that time to the present, for it was adopted by Parliament in 1852. He moreover used two candles instead of one, in order that the light might be intensified, and the rate of combustion equalized. This also had become the practice in photometry. After a time, however, the sperm candle became a subject of perplexity, from the circumstance that during the American war, when the long fibre cotton was difficult to obtain, a short fibre cotton was used in the construction of the wick, and thus the combustion of the candle became irregular. More recently, in consequence of the increasing value of spermaceti, the candle was frequently adulterated with paraffin and stearic acid, so as to be untrustworthy as a photometrical standard. There was a want, therefore, of a radical improvement in this particular. In the next place, the photometer was a very imperfect instrument, with reflecting surfaces, and with the Brunsen disc exposed on both sides to extraneous light. This he remedied by the use of screens, and by inclosing the disc in a chamber or camera, which only permitted the access of the direct light from the gas and the candles, as was seen in the photometer which bore his name. The burner also, which was described in the Great Central Company's Act as an Argand of fifteen holes with a 7-inch chimney, was so constructed by different makers as to give, with the same gas, when burning at the same rate, an illuminating power that ranged from about ten to fifteen candles. This was caused by the want of uniformity in the size of the apertures through which the gas escaped from the burner, and in the diameter of the hole through which the air passed to the interior of the flame. There was not, in fact, at that time the slightest provision for the proper adjustment of air to gas; and therefore, with different burners, of Act of Parliament quality, the photometrical results were most discordant. Very little experimental inquiry showed that the smaller the apertures, and the higher the pressure at which gas issued from the burners, the lower was the illuminating power; and, on the other hand, the larger the hole which gave access of air to the interior of the flame, the lower also was the illuminating power. A careful examination of these facts by Mr. Sugg and himself led to the construction of the burner which bore their names, and which, until recently, had been the standard burner for photometrical purposes—the size of the internal hole being graduated according to the quality of the gas; and thus, with the assistance of perforated discs upon the gallery of the burner, the proper adjustment of air, and thereby the proper combustion of gas of different qualities, had been approximately secured. More recently, however, the improvements of Mr Sugg in the same direction had produced a still better burner, which was rightly proposed as the standard burner for general use. These improvements consisted, first, in the reduction of the pressure of the gas to a minimum at the point of combustion; secondly. in a well-regulated supply of air to the interior and exterior of the conical flame; and thirdly, in the adoption of means for keeping down the temperature of the burner, in order that the issuing gas might not be expanded by the heat of the burner. Possibly further improvements might yet be made in the construction of test burners, but sufficient progress had already been made to justify the proposition of Mr. Sugg that his burner should be accepted as a standard instrument, so that litigation and trouble on this head might be in future prevented. And now came the important question—how was the burner to be used? Should it be, after the old Parliamentary fashion, of forcing 5 cubic feet of gas through it per hour, whether the burner consumed it properly or not, or should the quantity of gas necessary to produce a flame of given intensity or of given measurement be determined? It was, he thought, abundantly evident, that the present practice in this country of forcing 5 cubic feet of gas an hour

— FIG. 1. —



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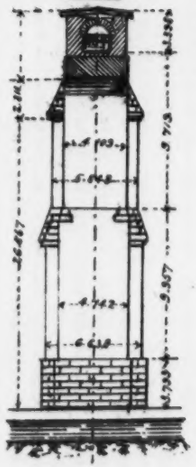
— FIG. 4. —



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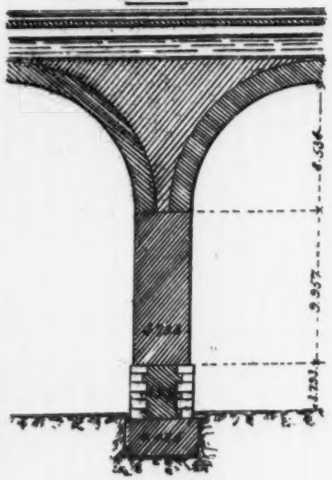

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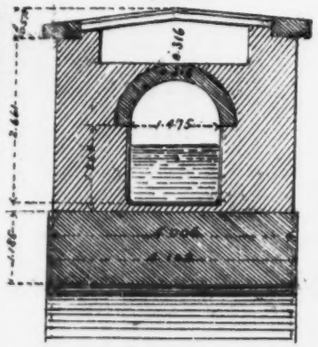

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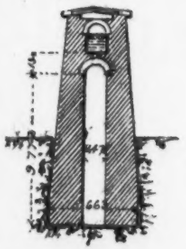

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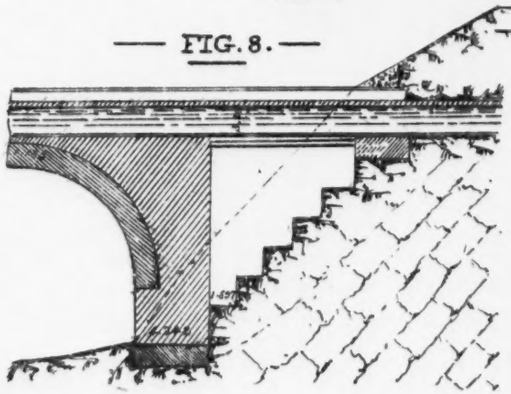

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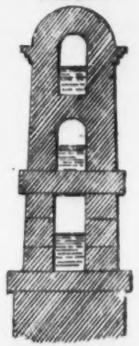

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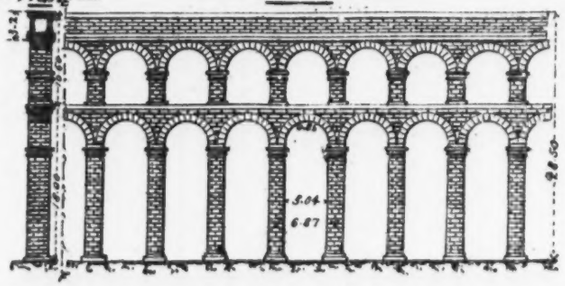
— FIG. 11. —

— FIG. 12. —



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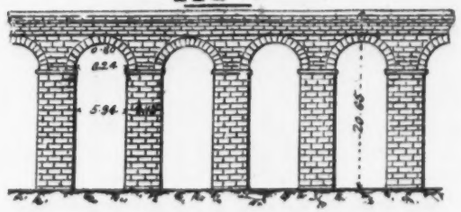
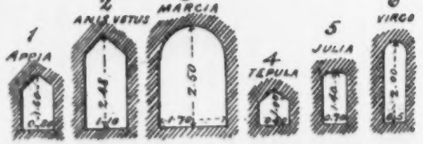
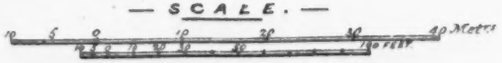
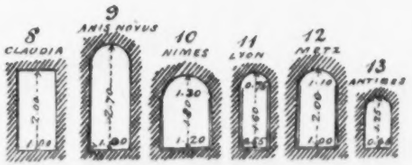




— SCALE. —





through a burner, whether it would effectively carry this quantity or not, was radically wrong; for with any given burner and chimney, suited for the proper combustion, and full development of the illuminating power, of that quantity of gas, it must be that when gas of inferior quality was passed through it at the same rate, the gas would be over-oxidised, and therefore made to appear of less illuminating power than it really was. On the other hand, superior gas would be under-oxidised, and would escape as smoke without developing its full value. This was actually the case with the Birmingham burner referred to, which at the time of the passing of the Companies Act in 1864, and at the request of the Parliamentary Committee, he designed in conjunction with Mr. Bowditch, as the standard burner for 14-candle gas. They were compelled to use a metal top, in accordance with the instructions of the Committee; for the Corporation of Birmingham, who were in opposition to the gas company, would not have a burner with a steatite top, and this they would now regret, having lately purchased the works of the company. This burner was exactly suited for 14-inch candle gas, but if the gas was better or worse than this, the burner would do it injustice. The same was the case with other standard Argand burners, as the Dublin, Leamington, etc., which had been constructed on their principles; and therefore, if Parliament insisted on the passing of 5 cubic feet an hour through a test burner, the gas companies should be permitted to select that burner which, while fulfilling the conditions of the Act of Parliament, developed the illuminating power of the gas to the fullest extent. It was far better, however, that the second alternative should be resorted to, namely, the use of a standard burner, like a standard measure, as Mr. Sugg proposed, and the determination of the quantity of gas to be passed through it, so as to develop a flame of standard intensity or standard height, The intensity of the flame might be measured, as was the practice in France, under the advice of Dumas and Regnault, by keeping it exactly equal in illuminating power to that of an Argand burner, of prescribed conditions, consuming a given quantity of colza oil. Or it might be measured, as he had proposed, by ascertaining its penetrating power in passing through a medium of given opacity—say a piece of dark bottle glass cut in wedge shape. But if the height of the flame were the test, nothing was easier than to fix on such a height as would be best suited for the maximum development of light and then to determine the quantity of gas per hour necessary to produce such a flame. Long ago, the late Dr. Fife showed that the quality of gas, as regarded illuminating power, might be determined by burning the gas from a jet of given dimensions, and observing the rate of combustion necessary to produce a flame of given height, or by observing the height of the flame when the gas was burnt at a given rate. Under the name of Lowe's Jet Photometer, the last method was practically in use at gasworks for the purpose of ascertaining the quality of the gas as it was made; and there was no reason why the other plan might not be pursued, for the principle was manifestly correct.

The illuminating power of gas was dependent on the proportions of the rich and heavy hydrocarbons which the gas contained; and as these were of much higher specific gravity than the hydrogen and marsh gas, which were the chief constituents of coal gas, it was evident that the density or specific gravity of the gas would rise in proportion to the quantity and quality of the hydrocarbons contained in it. Now, the experiments of Dr. Fife, as well as the more recent investigations of Professor Graham, had shown that the flow of gas through a small orifice was inversely proportional to the gravity of the gas. The law, indeed, as expressed by Professor Graham, was that the velocity, or rate of flow, was inversely as the square root of the density. If, therefore, the flame was used as the exponent of the density, as it really was in the case of the heavy hydrocarbons, its height under a constant rate of flow would determine the density or quality of the gas; while with a flame of a given height, the rate of flow would be the means of arriving at a like result. This was the principle which the Author had in view, and no doubt it was susceptible of practical application. His experiments, indeed, showed that this was the case, and that the results obtained by it were accurate and trustworthy. The simplicity of the process was, moreover, a great recommendation, as it was capable of being applied under all circumstances, without the complicated machinery at present in use; only a standard burner being required with a handy, portable, and accurate meter, together with a delicate thermometer and a good aneroid barometer.

Mr. Vernon Harcourt remarked that he had not had an opportunity of seeing the apparatus previously, and therefore could not presume to offer an opinion upon its practical value. One or two points mentioned by the Author were of great interest, and one certainly which he had not previously understood, viz., that flames produced by different samples of gas at the same burner did not differ from one another except in size, and that provided the total surface of the flame was the same, whatever the quality of the gas burnt, the amount of light it gave was the same. That was certainly at variance with common observation as to coal gas. Remarks were often heard as to the apparent brilliancy of the light, which were intended to refer to the effect produced by a given area of flame upon the eye; but from what Mr. Sugg said he understood a 3-inch flame, from the same burner, would always give the same amount of light, whatever the quality of the gas. Another question suggested by the Paper was as to the reason why the size of the flame should vary, as it was known to vary, other conditions being alike, with the quality of the gas. One reason for this was the decomposition of the heavy hydrocarbons at the high temperature of the flame. It was well known to chemists that at that high temperature these hydrocarbons were resolved into a larger volume of lighter gases. As soon as the gas had passed through the burner and had been heated part of it was decomposed, and a larger volume of gas was formed; so that actually with a richer gas, though the quantity passing through the meter was the same, the quantity in the flame was a larger volume, and therefore, to obtain a flame of a given length, it was necessary to burn less gas as measured by the meter. He did not understand why an Argand burner with a 3-inch flame was used, because, comparing the instrument with the jet photometer, it appeared to have at least two disadvantages. It would seem an easy matter to determine the height of the flame, but actually its top consisted of a number of shifting peaks, and although it was possible to arrive at some rough average, yet its position could not be determined with accuracy. The error so produced appeared to be increased by using so short a flame. With a flame 6 inches long a small error as to the position of the top of the flame mattered less than in the adjustment of a 3-inch flame. The uncertainty as to the position of the top of the flame in the latter case was much greater, and the error caused by the uncertainty was greater. He could not understand why, in this instrument, such a flame was adopted, instead of the long flame with a well-defined top which was used in the jet-photometer.

Mr. Law said that portion of the profession engaged in gas engineering was much indebted to Mr. Sugg for the attention he had given to the subject of the standard Gas Burner. No doubt the burner he had introduced was that which gave the most uniform results, and without which the present perfection of gas photometry could never have been attained. The most imperfect part of photometrical apparatus was that employed as the standard by which the instrument could be perfectly adjusted. Whatever photometer was used—whether Bunsen's or Wheatstone's, or the wedge—they all depended ultimately upon the estimation of the human eye; and not only did that estimation differ in different individuals, but in the same individual in different states of health or in other physical circumstances. He had placed on the table an instrument which he believed would become the standard photometer, because it was entirely independent of the physical conditions of the human eye, and really measured the intensity of the light by the velocity of its revolution. It was a recent discovery of Professor Crookes, and seemed to presage some great discoveries in reference to those extremely attenuated media of which Mr. Grove first showed the correlation, such as light, heat, magnetism, and electricity. The instrument was actuated by the intensity of the light. The cause of its revolution was not so important to inquire into in reference to this subject, but it was a fact that the velocity would vary according to the intensity of the light. It was most sensitive in its operation; it consisted of arms of aluminum with discs of talc, which were black on one side and polished on the other, and the influence of light upon it produced the revolution; it was in a perfect vacuum. The mode of making use of it would be to let it move at such a low velocity as would enable the revolutions to be counted; and the number of revolutions would determine the intensity of the light. If it was further improved by making one of the arms magnetic, a registering apparatus might be put outside, so that the number of revolutions might actually be recorded. In reference to the proposed mode of estimating the illuminating power of gas, he could speak from experience of the great value of having some simple mode which did not depend upon the estimate of the eye of different persons, such as in the Bunsen photometer; for he knew by experience, that fiscal engineers in foreign parts, not accustomed to this kind of observation, would estimate the gas at two or three candles different from the practised gas maker who was used to the instrument.

Mr. Barlow, Vice-President, did not think Mr. Crookes' instrument had been presented in a form suitable for measuring light alone, because it was affected not only by light, but by heat. It would require some provision to exclude the action of heat, because the worst gas was that which gave much heat and little light; and the instrument would be caused to revolve by gas of inferior quality almost as much as it would be by gas of high illuminating power. Care would therefore be required to exclude the effect of heat, otherwise bad gas might be registered as good.

Professor Abel observed that Mr. Crookes had already given serious attention to that subject, and no doubt would be able so to arrange the apparatus as to shut off the rays of heat, and to obtain trustworthy records of the different illuminating power of the light emitted from different sources. He had sanguine anticipations of the results that Mr Crookes would obtain in this direction. He had listened with great interest to Mr. Sugg's communication. The only point that occurred to him in reference to it was the one Mr. Harcourt had noticed, viz., the uncertainty of measuring the exact height of so short a flame.

Dr. Pole said it might perhaps be useful to state what was actually done in regard to testing gas, and the employment of burners in London. The ordinary method of testing gas was by means of the photometer, by putting a gas flame on one side of the disc and a standard candle on the other and comparing the effect of the two in the usual way. Then the question arose as to what kind of burner should be used. Dr. Letheby had given a good historical account of what had been done with regard to burners, and Dr. Pole would take it up at about the point when the Act of 1868 was passed, which directed for the first time on a good scientific basis the testing of gas throughout London, and when a new clause was introduced with regard to the construction of the burner. It was not attempted to define what kind of burner should be used, but the clause left it to the Gas Referees to prescribe the burner: "The burner shall be such as shall be the most suitable for obtaining from the gas the greatest amount of light, and be practicable for use by the consumer." The illuminating power of gas varied immensely according to the burner used; it was supposed a sensible consumer would get the best burner he could, and the company of course had a right to have their gas tested by that burner. It came to the same thing as saying that the company should have their gas tested by the best burner which could be used by the consumer, and that was how the legislation stood at this moment. The Referees examined a great number of burners, and chose the one called Sugg's Standard London Burner as answering that condition; and that it had been used by the public was proved by its large sale. It also gave a pretty high illuminating power to the gas tested by it. It was prescribed by the Gas Referees and had been in use ever since, being considered a very good burner.

Then came another question, the quantity of gas passed through the burner; and here it was found that the same burner would give different results with gas of the same power according to the quantity which passed through it. Thus 5 cubic feet an hour passed through a burner would give one result, but if in the same burner only 2½ cubic feet an hour were burnt it would not give the same proportionate result as before. He had

occasion to go into the cause of this some time since, and found a curious law applicable to burners generally. It was expressed by the equation

$$L = m\ I\ (q - c).$$

Supposing L to be the light given off by the flame of a burner, I the illuminating power of the gas, and q the number of cubic feet of gas burnt, per hour; m and c were two constants, and that equation would give for all burners he had tried the light given out by burning a certain quantity of gas. The values of m and c came out as follows. For Argand burners generally m varied according to the goodness of the burner, from 0.2 to 0.33, and c was pretty nearly 2. For flat-flame burners m varied from 0.1 to 0.2, and c was about 0.5. The inference was, with whichever burner, that the more gas burnt in the burner—that was, up to to its maximum power, so that it did not smoke—the better was the result obtained. That led to this, that since the burner ought to burn the gas to the best advantage, it was necessary to have the flame pretty high, and the standard London Argand was made so as to burn about 5 feet an hour without smoking. That was how the burners used in testing gas in London had been arranged. Then came this difficulty. The gas of course varied in power; no gasworks could keep their gas always of the same strength; sometimes it was a little less than at other times, and sometimes more. When the illuminating power of the gas increased there was a tendency to smoke and flare above the chimney, and that had to be corrected. The examiners could not alter the quantity because the Act mentioned 5 feet an honr; all they could do was to check the smoking by putting on a different chimney, which did the gas harm. On the other hand, if the power of the gas diminished, then the burner was not doing its best, as the flame became too low. Now, without going so far as Mr. Sugg had done by changing the plan altogether, the liberty of altering the quantity would, he thought, be a great convenience; when the gas became of a higher illuminating power, the quantity could be reduced, and when it had a lower illuminating power the quantity could be a little increased. This would have another advantage, inasmuch as it would represent more nearly what the public did. The public, in using the gas, kept the flame at pretty nearly the same height, and if the gas was too rich, rather than have it smoke, they turned it down, or if it was too poor, they increased it. Hence, the power of varying the quantity in testing the gas, according to the illuminating power, would in reality correspond to the ordinary condition of practical use, one of the objects aimed at by the legislature.

Dr. Pole then referred to the late discoveries of Mr. Crookes, particularly as to the possibility of measuring the intensity of light by its mechanical radiating force, and he described, at some length, the several ingenious methods by which Mr. Crookes, in a paper lately read before the Royal Society, had shown how the intensity might not only be accurately measured, but automatically recorded. He did not assert that these instruments were at present in a position to be used for a photometrical purpose of the importance of gas-testing in London; but Mr. Crookes' discoverics contained the germ of a great improvement, which might one day be of considerable value.

(To be continued.)

Slate in Buildings.

The use of slate in buildings is rapidly becoming popular. This material, the valuable qualities of which first became generally recognized in its employment for roofing and imitation marble mantles, is now applied to many and varied purposes. Its strength and durability, together with its attractive appearance, commend it to architects and builders. Slate for stairway is steadily growing in favor, and for this purpose it clearly and signally excels wood, iron, marble, or any other material. It is strong and clean, and does not become smooth and slippery from wear. In many of the recently constructed buildings in this city and elsewhere slate stairways have been adopted, and they give entire satisfaction. The stairways in the *Tribune* building, which have elicited much favorable notice, are composed of slate from the quarries of the Penrhyn Slate Company. This company, whose offices and salesroom are on Union square in this city, have made a specialty of this kind of work, and have introduced it into many of the public buildings and schools throughout the country. Their enameled slate, made in imitation of the various marbles and granites, and used for mantles, wainscoting, furniture tops, etc., possesses many merits. It presents a perfect resemblance to the stone which is imitated, and surpasses it in being able to resist the action of acids and grease, which often deface and destroy other materials. Slate can be used to great advantage in laundries and other places where it is constantly brought in contact with water.—*N. Y. Tribune.*

Railway News.

The Green Bay Railroad will be completed to La Crosse this week.

The route for the contemplated North Shore Railroad, on Long Island, is now being surveyed.

The Reading Railway Company, it is reported, are about to establish a line of steamers from Philadelphia to Brazil.

Preparations are now making to lay a second track on the Troy and Boston road, from Troy to Eagle Bridge, 23½ miles.

One of the Handyside Steep Gradient Locomotives is now working on the Hopton incline, Derbyshire, of the London and Northwestern Railway. This incline is one in fourteen.

The Columbia & Port Deposit Railroad is now completed from Columbia, Maryland, to the mouth of Fishing Creek, two miles above Peachbottom and half a mile below Fite's Eddy.

The freight depot of the Dayton short line R. R. in Cincinnati was totally destroyed by fire last week. Freight to the value of a quarter of a million dollars was burnt, with very little insurance.

The Pensylvania Railroad Company is about to make somewhat extensive improvements in the nature of terminal facilities upon the site of the old Navy Yard, Philadelphia, purchased for it last spring.

The Chicago and Alton Railroad company has purchased the Chicago and Wilmington Coal company's track, and will soon begin operations to open a connecting line from Braidwood, Ill., to Coal City.

The Chicago and Northwestern Railway Company has decided to build a branch line from Sleepy Eye, fifteen miles beyond New Ulm, in Brown county, Minnesota, to Redwood Falls, in Redwood county, a distance of thirty miles.

It is stated that work will begin on the Sarnia, Chatham and Erie Railway of Canada, on the first day of October next. It is to extend from Sarnia, Ontario, southward through Chatham to Blenheim on Lake Erie about fifty-five miles.

Work has been resumed on the Pittsburgh, Virginia and Charleston Railroad, and it is expected that it will be completed as far Brownsville about Christmas. Cars have been running from Pittsburgh to Monongahela City for a number of years.

On the Columbus and Toledo road, tracklaying is going on above Fostoria. The track where finished is being ballasted and put into shape for the running of trains. The grading along the whole line is about finished and ready for the rails.

From the Railway Report of New York we learn that the state now has 5,499.28 miles of road, an increase of 187 miles during the past year. The capital stock of all the roads is $615,982,310, and the cost of road equipment $626,575,861.78.

A company called the Keokuk & Northwestern Railway was organized at Keokuk, Iowa, Sept. 16, the object of which is the building of a road on a projected line to Iowa City. The line is graded part way, but no work has been done on it for the past five years.

Over three-quarters of the grade between Lansing and Flint, Mich., on the Chicago & Northeastern Railroad, is completed, and track-laying is progressing. About 100 men are emyloped between Lansing and Battle Creek, re-tieing and ballasting-up the road.

The Baltimore and Ohio Railroad Company have notified shippers to discontinue shipments via that line to Savannah in consequence of the yellow fever in that city. A strict quarantine is maintained at that port, and steamers have ceased running until the epidemic abates.

The Geneva and Ithica Railway from Geneva, N. Y., to Sayre, Pa., 77 miles, was sold on Sept. 2, under the first and second mortgage, and has now passed into the hands of the Lehigh Valley Company, subject to a mortgage of $600,000. The road was bought in for $65,000.

Track is now laid on the Texas Transportation Company's line from Clinton to Houston, Tex., 7¾ miles. Clinton is the head of the new ship channel which has been dredged out in Buffalo Bayou, and the new road is intended to connect the landing place of the Morgan steamship lines there with the roads entering Houston.

A movement is on foot to extend the Pittsburgh and Castle Shannon (narrow gauge) railroad to Washington, Pa., there to connect with the Waynesburg and Washington road, well on towards completion. With a short additional line from Waynesburg to the Baltimore and Ohio, a large and rich territory would be opened to railway traffic, hitherto without such advantages.

A party of foreign capitalists passed over the Covington, Columbus and Black Hills railway (narrow gauge) Sept. 15, and it is stated that arrangements have been made to complete 150 miles this year and to reach the Black Hills in 1877. The sanguine projectors call this the first link in the projected route to Portland, Oregon, via Black Hills and the Yellowstone National Park.

Prominent parties interested in the Denver and Rio Grande and also in the Atchison, Topeka and Santa Fe Railroads have been examining the San Juan Valley, Colorado, and from the favorable impressions produced, it is surmised that this valley will soon be the theatre of railway construction, both for lines looking towards Southern Utah and Northern New Mexico.

The Stevens Point (Wis.) *Journal* says: A portion of the graders employed on the Wisconsin Central have been discharged, it being, as we are informed, the intention of the company to suspend work on the line as soon as Flambeau is reached. Thirteen miles of track are to be laid on the other end, and this will leave a gap of only eight miles to be completed next spring.

The certificate of incorporation for the Ohio River and Virginia Railway was issued last week. The road is to extend from Cincinnati through Hamilton, Clermont, Brown, Adams, Scioto, and Lawrence counties, and have a terminal point in Lawrence county opposite Huntington, West Virginia. The capital is $1,000,000, and Joseph Kinsey and others are named as incorporators.

The sum total of railway lines through the principal countries of the world now reach a distance nearly fourteen times the circumference of the globe, or once and a half times a journey to the moon. Of this total the United States lines extend 85.586 miles; Great Britain, at home and through her foreign domain, 66,101; Russia crosses Europe and Asia with lines, 34.914; France, 30,779; and the German Empire, 18,999.

The survey and location of that portion of the Portland, Dalles & Salt Lake Road from Corinne, Utah, to Snake River, Ihaho, is being completed by the engineering corps under C. L. Ericson. The contracts for grading from Corinne to Snake River have been made with Alex. Toponce, and the grading is to be completed to Maland City, a distance of 50 miles, by the 15 of Dec., 1876, and the whole of the grading to Snake River by the 1st of Oct., 1877.

The line of the Mobile and Alabama Grand Trunk Railway, as surveyed, is about 230 miles in length, extending from Mobile, Ala., to Birmingham, Ala., with a branch to Selma, Ala., forty miles—making the total length of the line, as projected, about 270 miles. Of this about fifty-nine miles, extending from Mobile to Jackson, have been completed. It is now proposed to build an extension to Uniontown, on the Alabama Central Railroad, a further distance of seventy-eight miles.

The Helena (Montana) papers are somewhat discouraged at the slow progress of the Northern Pacific and urge the construction of a narrow-gauge railroad from that place to Fort Benton, the head of navigation on the Missouri. The distance is estimated at 140 miles, and the cost at $1,500,000. It is proposed that the various counties on the line shall give a bonus of $70,000. Later: Captain S. B. Coulson, of the Coulson line of steamers of the Upper Missouri river, telegraphed to Helena, Montana, August 24th, from Yankton, that he was ready to undertake the construction of the Helena and Benton Railroad, and that he will build and completely equip it for $700,000.

Contractors' Intelligence.

Mr. J. G. Rutherford, of Columbus, Ohio, has been awarded the contract for laying the iron the whole length of the Cincinnati and Portsmouth railroad.

On Sept. 21, the city treasurer and the committee on finance of Boston, opened the proposals for the $2,000,000 loan authorized by the city council for the purpose of defraying the cost of furnishing an additional supply of water from the Sudbury river. The loan will be issued in certificates dated Oct. 1, 1876, and due in thirty years from that date. The entire amount was awarded to Blake Brothers & Co., whose bid was $111.07 currency, the rate of interest being 5 per cent., payable in gold.

A telegram from Montreal says:—Much speculation is indulged in as to the result of tenders for Sec. 15 of the Canada Pacific Railway. The lowest tenders are as follows: Kane & Co., of Montreal $1,540,000; Sutton & Co., of Montreal, $1,560,000; Green & Co., of New York, $1,685,000; Sifton, Ward & Co., of New York, $1,800,500; Messrs. Broison & Whitehead, Alexander, McDonnell & Co., Booth & Co., Steacy & Steacy, and other tenderers range from $1,800,000 to $2,000,000. It is not likely that the final award will be made for some days.

A mass meeting in favor of the Fort Madison and Northwestern railroad was held at Madison, Iowa, the 13th inst. Speeches were made by many leading citizens, and committees were appointed to raise subscriptions in the back townships. All but two or three having insured the necessary subsidies, a party of contractors have just returned from a thorough examination of the proposed line of the road. They express themselves highly pleased with the route. It is probable that the contract will be closed and work begun in a few weeks.

Proposals for the drainage pumps for the south part of the town of Hyde Park, have been submitted by L. Soulerin, of this city: by Messrs. Safely, of New York; Chas. Creighton & Co., Lyman Bridges & Co, W. McGregor & Co., John Mills, of South Chicago; H. H. Scovile, George Judd & Co., 92 LaSalle street; Providence Steam Engine Company, E. B. Talcott, and Alfred Guthrie. All the bids were referred to the Committee on Drainage for further consideration. The Village Engineer was added to the committee.

The U. S. Surveyor General at San Francisco has received notice that the proportion of the appropriation for surveys of public lands for that department will be but $33,500. The amount last year was $90,000, and surveys were made at the rate of twelve and fourteen dollars per mile. The surveys this year will be done at reduced rates—$6 for section lines, and $7 for township lines. The office force was cut down on July 1st by the discharge of sixteen men and four ladies, leaving a force of only ten men. Surveyors are about starting into the field. Contract have been awarded to Messrs. Gilchrist, Richards and Fairchild, of Oakland, who start in near Coulterville, in Mariposa county.

The Mayor and Comptroller, Sept. 19th, closed a contract with the Chicago Gas and Coke Company to supply gas for public purposes on the North and South sides, at the uniform rate of $1.50 per 1,000 cubic feet. The city authorities on the 20th inst. advertised for bids for lighting the West division of the city with oil. The competition bids fair to be very lively. It is known that bids will be received from responsible parties in Boston, Cincinnati, Pittsburgh, and Milwaukee, in addition to two or three firms of this city who intend to put in bids. The bids will be opened on Saturday the 30th inst., and will be submitted to the council on the following Monday. Three-foot burners will be placed on the North and South side lamps in a few days.

Notes Continued.

The tunnel now building by the Deleware, Lackawanna & Western through Bergen Hill, Jersey City, will be completed and in operation by Nov. 1. It is 4 270 ft. in length and cost, exclusive of land damages, $900,000.

Arrangements have been made between the Sarnia and Lake Superior line of propellers, the Northern Pacific Railway, and the Red River line of boats for the transportation of the Manitoba surplus wheat, the rate from Winnipeg to Montreal or New York not to exceed 40 cts. per bushel.

European astronomers profess to have discovered Leverrier's planet, Vulcan, which the great astronomer some 20 years ago, said must exist between Mercury and the Sun. It has been seen twice now in its transit across the Sun's disc, but it is doubtful if its elements can be calculated from any data yet obtained.

The Pacific Mail steamer, City of Pekin, which arrived in San Francisco on the 7th inst., made the run from Hong Kong in twenty-two days and eleven hours, and from Yokohama in fifteen days and nine hours. This is over twenty hours ahead of the famous passage made by the Oceanic, and is the best ever made.

Eighty-four vessels were counted on the Kennebec River recently, between Richmond and Hallowell, loaded, loading, or waiting to be loaded with ice. There were also counted thirty-eight ice establishments, each establishment having from two to twelve houses, Hundreds of men find employment and good pay at work shipping "frozen water."

Work on the big oil-pipe which is to connect the Pennsylvania oil regions with Philadelphia has begun. When finished a steady stream of petroleum amounting to 6,000 barrels a day will flow from the oil well to the great Pennsylvania reservoir. It is reported that Chester, Pa., will be the eastern terminus. The work is to be prosecuted from both ends.

The contract for the construction of the entire line of the Cincinnati and Portsmouth road, (100 miles, 3 feet gauge) has been let to John W. Rutherford & Co., of Columbus, for about $8,000 per mile, the road to be completed by May 1, 1877. There were fifty-nine bids. The line is quite direct and has some heavy grades, one as high as 142 feet to the mile. Work will begin at once.

The United States government steamer Montana stationed at Davenport, Iowa, Capt. Davis, started Sept. 21, from that port on the upper Mississippi. The Montana will engage in the necessary channel work for which the engineering bureau has allowed $100,000. The $4,000 each for clearing sand bars in front of the cities of Dubuque, Burlington, and Fort Madison will not be used until spring, the season being regarded as too short for effective operations.

Steam Dummy Engines are now run in New Orleans by the "Crescent City Street Railroad Co." from Clay Station on Canal St., via the cemeteries, to Lake Pontchartrain. These dummies pull from two to seven loaded street cars in one train at a speed of 12 miles per hour. The "Canal St., City Park and Lake R. R. Co." also runs steam dummies from the corner of Basin and Canal streets to the lake via Bienville street. As an experiment these dummies have proved very successful and they will undoubtedly be continued by the lines now using them.

It is stated that the peat works established this season and in successful working order at Newtonville, near Port Hope, on the line of the Grand Trunk Railway are creating a favorable impression in western Canada. The people speak highly of the prospects of being supplied at home with the new fuel. The quality of the peat in the locality referred to is pronounced by experts to be the most solid of any as yet found in the Dominion. Shipments of peat have been made the last week, for testing, to Montreal, Ottawa, Milwaukee, Boston and Trenton, N. J.

The construction of a new subway, making another Thames Tunnel, was commenced at Woolwich at 4 o'clock yesterday morning. The work began by boring on the north side of the river, and it is expected to be completed within six or nine months, it being assumed that the ground under the river consists of a bed of chalk, and therefore favorable for the purpose. The new tunnel is being constructed under contract by Messrs Sharpe of Cannon street, city, under the superintendence of Mr. Gilbert, engineer. It will open a subterranean communication between the two counties of Essex and Kent. The scheme originated in consequence of nine men being drowned on a foggy morning while crossing the Thames to their work in a small boat; the steam ferryboat which usually conveys some thousands per day between North and South Woolwich not venturing to run.—*London Times, August 24th.*

The oldest shipbuilding firm in the United States is doubtless that of S Gildersleeve & Sons, Gildersleeve's Landing, Conn. The senior member began building in 1821. The present firm was formed in 1838, or thirty-eight years ago, and its members are father, sons, and grandson. The grandfather of the senior member, named Obadiah, was a shipbuilder, and moved from Sag Harbor, Long Island, to the town of Gildersleeve's Landing at the commencement of the Revolutionary war, or one hundred years ago. His son Philip, the father of the senior of the Gildersleeve firm, was also a shipbuilder, and carried on the business. In 1798 he built the United States ship of war Connecticut of twenty guns. The present Oliver Gildersleeve, the junior of the firm, makes five generations of master shipbuilders of the same family that have carried on the business of building vessels in the same place and yard for one hundred years. Since 1821 the Gildersleeves have built 114 vessels.—*Inter-Ocean.*

Water Works, Ancient and Modern.*

BY E. H. D'AVIGDOR.

(*Continued from page* 311.)

It is impossible to describe the details of the construction of the distributing or supply reservoirs within the limits of this paper. I must be satisfied with sketching their general arrangement, and refer those who desire to know more to the works of the authorities I have frequently had occasion to mention. But from the above explanation it will be sufficiently clear, that the water towers or cisterns, which were supplied with inferior water, had no private pipes, while those fed by Marcia, Claudia, and Virgo, on the contrary, contained hardly any others. The contents of all the large reservoirs or castles taken together appear to have been only about 20,000 cubic metres or 700,000 cubic feet. There could therefore be no question of storage, nor even of regulating and balancing the distribution of water. It is evident then that the level of the water in the cisterns could not really be kept constantly at the theoretical height of 12 in. above the outlet pipes, notwithstanding the overflow, and as some houses were situated much higher than others, drawing their water from the same cisterns it follows that one householder obtained a much more liberal supply than another, even though the pipes supplying the two houses might be of the same diameter. The Roman unity was the *quinarius*, that is the quantity flowing through a pipe of one and a quarter *fingers* diameter under a head of 12 in. This is equal to 420 litres, or about 92 gallons in 24 hours. To prevent too great an irregularity in the supply, there was a rule that all private pipes were only to have the above diameter for a distance of at least ten paces from the cistern. Beyond this radius they could be enlarged or constructed at the will of the householder. Yet the concessions or water-right caused very great injustice and much ill-will, and M Belgrand has calculated that some houses in Rome obtained ten times as much water as others.

It will be seen by Table I. (see page 312 *ante*), that in the reign of Augustus, when Rome had about 350,000 inhabitants within its walls, there was a supply of something like 680 gallons per head, that is about forty times as much as the valuation for Vienna. But there were in ancient Rome no less than 1352 public fountains, 591 jet fountains, 19 large fortified camps or barracks, 95 thermæ or immense public baths, and 39 arenas or theatres, all of which were supplied with a superfluity of constantly flowing water. Nay, more, by the measurements which Colonel Blumensthil, the chief engineer of the new aqueduct Pia at Rome, has taken the trouble to make in the ancient aqueducts, and by an accurate gauging of the springs which supplied them, it appears certain that about 400 millions of gallons daily ought to have reached Rome, and, therefore, that nearly half the total quantity was lost or wasted on its way. I do not know what the muncipal engineers at Vienna would say if the loss in their aqueduct were even 5 per cent.; I for one would not dare to write or speak on the subject of the new water works. This immense loss arose partly through neglect of the necessary repairs in the aqueducts, but still more through the water being

* A course of papers delivered at the Austrian Institution of Engineers and Architects, December, 1875, and January, 1876.

positively *stolen*. For one of the principal favors by which the state and the emperors were in the habit of rewarding minor services, was by granting concessions for the *lost* water, that is for the water which escaped through the overflow of the reservoirs, cisterns, and public fountains, or through the defects in the aqueducts and mains. The consequence, of course, was that every landed proprietor who had obtained a concession for the waste water escaping from an aqueduct passing through his grounds was anxious to increase this waste as much as possible—and from this wish to intentional injury was but a step. The overseers and slaves in charge were constantly bribed to abstain from repairing damages which had arisen, or to cause new ones to arise, and these abuses reached such a pitch that one aqueduct (Tepula) brought *no* water whatever to Rome during several years, the whole having been wasted, or rather abstracted on its way. We must further observe, that many aqueducts were erected in order to gratify ambition or to obtain popular favor for the founder, who did not much care about its being kept in repair after his death, as long as he had attained his immediate object by constructing it. The founders, therefore, never left any money for the maintenance of the works; and the city had to take charge of them. In the turmoils of the many civil wars, and the frequent absence of any conscientious management, the grossest abuses inevitably arose out of the concessions for waste water, and the moneys devoted by the town to the maintenance of the works. And it appears that the Cæsars were all of them much more inclined to build a new aqueduct than to restore an old one. The irregularities of the water supply were still further increased by the nature of the mains and distributing pipes, which, as I have mentioned, were mere lead plates soldered into a pear-shaped section, incapable of resisting even the most moderate pressure and liable to injury by a common knife, so that any evil-disposed person could tap the main almost wherever he pleased. At a later period, indeed, the Romans appear to have used short clay pipes; lengths of such mains have been discovered, consisting of 2 ft. spigot and socket pipes carefully laid in and covered with a bed of concrete. These have outlasted all the lead pipes, and are still frequently found in good condition. They appear to have been employed principally to connect the reservoirs with the towers or cisterns.

Householders could only obtain the right of water supply by a petition to the consul, and in later times to the emperor himself; even then, however, with difficulty. They were matters of favor and rewards of merit, they applied only to the person to whom they were granted, were not transferable by gift or sale, and lapsed with the death of the owner or the sale of the house for which they had been granted. On the other hand, the poorer classes had the immense advantage of gratuitous access to the numerous wash-houses and magnificent baths, besides, of course, the use of street fountains. The water granted to householders was incredibly cheap. During the reign of Augustus the whole income from all the aqueducts only reached about £3000. The private water rate was about equivalent to one farthing a year for each gallon supplied daily. If we consider the cost of the aqueducts it is obvious that this rate could not even approach the mere interest on the capital expended, since Claudia, the cheapest of them all, cost a sum about equivalent to £300,000 sterling. This is about equivalent to £4 per yard run Anio Vetus cost about £600,000 or £6 10s. per yard run. These figures are not very different from the prices now paid; for the Vienna aqueduct, which is about 110,000 English yards long, cost in round figures £900,000, or a little over £8 per yard run.

To give some notion of the proportion of Roman works as compared with modern ones, I have sketched a few arches of the three principal aqueducts (see plate), to the same scale as the Modling aqueduct. Having now imparted some few data about the water works of ancient Rome, I must mention very briefly some of the great works the Romans erected in the provinces.

The most perfect and beautiful aqueduct they ever constructed is no doubt that of Nimes, which is about 35 English miles long, and brings the water from springs at a level of about 240 ft. above the sea to a reservoir in the ancient town at a level of 179 ft. I mention this work on account of the immense row of arches near Vert, and the beautiful and justly celebrated Pont du Gard. The former is 2145 yards long, and from 6 ft. to 50 ft. high; it has 256 arches of different spans, and piers up to 7 ft. in thickness. The latter is constructed in three stories, it is 158 ft. above the stream at its highest point, and the principal opening has a span of no less than 78 ft. The large arches of this magnificent aqueduct afford an interesting example of the mode of construction sketched in Fig. 2 (see plate), and mentioned above. The two lower stories are constructed entirely of ashlar without any mortar, the arches in four independent rings (see Fig. 5 of plate).

The three aqueducts of Lugdunam (Lyons), already mentioned in connexion with inverted syphons, are altogether about 120 miles long. Metz possesses a grand Roman aqueduct, of which one-half is used at the present day. The springs which then supplied the town still deliver 6,000,000 gallons per day. The aqueduct of Antibes is also still used, and is remarkable on account of its long tunnel of three English miles, more than a mile longer than the principal tunnel of Kaiserbrunn.

If I were to mention all the towns in France where the Romans erected aqueducts you would be weary of the list. I will, therefore, only add, that there was a remarkable two-branched aqueduct between Treves and Cologne (of which the ruins still exist) which supplied both these towns with water from the Eifel mountains. As a remarkable proof of how little the value of water and the purpose of these great works was understood in the middle ages, I may mention that, according to the German legend, this aqueduct was built to supply the works at Cologne with the delicious Moselle wine made near Treves. What measures were taken to insure a "constant supply" the legend does *not* mention.

Now we have reached the end of the Roman Empire, we may justly inquire, what has been done in the question of water supply since then, and whether the progress which the Romans made in a few centuries has been kept up since? We are obliged to confess that the art of water supply, like so many other arts, was completely lost to Europe during the dark ages, and that the very reason of the existence of the Roman works was forgotten. Still less, therefore, can we observe any progress. Here and there indeed we find indications that pure water was occasionally appreciated by some monarch or city more enlightened than the rest. For instance, Theodoric constructed the celebrated aqueduct of Spoleto, which crossed a valley near that formerly important city in ten beautiful pointed arches of 70 ft. span and 100 ft. high. This work is more graceful, if not actually grander, than anything left by the Romans. But from that period to the end of the 17th century very little was done to supply cities with water, and what had been done was allowed to fall into decay. The quantity of water used decreased in a remarkable degree, for it was considered a virtue never to wash at all. The monks did not remove their garments from one year's end to the other, and preferred wine when they were thirsty. All sorts of little tricks were invented with water, tiny fountains, water-clocks, saw-mills, etc., but these toys cannot be classed under the head of water works. The notion of a constant supply from springs seems to have been completely forgotten. People drew their water from the nearest stream, however troubled and dirty, without thinking that they were at the same time drawing from it the germs of all sorts of diseases.

So little having been done in the middle ages, it would be idle to analyse that little and to search everywhere for examples. I prefer giving you a brief summary of the water supply of Paris, which will serve as the best type of what was done during all these centuries.

When this city, which now contains nearly two millions of inhabitants, was limited to the two islands in the Seine (Cite and St. Louis), its water supply was as simple as that accepted by all other towns of the period. The dirty water was emptied into the river, and the clean(?) water was drawn from it again in another pail, if the servant chanced to be particularly clean—in the same one if she were dirty. The difference between dirty water (slops) and clean water as was supplied by this proceeding, is not very apparent. Later on, when the town extended on both banks of the river to some distance from them, the inhabitants found out that it was a long and tiresome job to have to fetch the water from the Seine. It does not appear that they had any misgivings whatever as to the quality of water so fetched—but it was too far for them. In the year 1183 A. D., therefore, King Philip Augustus annexed the aqueduct of the northern springs which had been erected some few years previously by the monks of St. Martin to supply their monastry, and made a present of it to the city of Paris. This is the first historical instance of a supply of water from springs since the Roman period; the aqueduct still exists and continues to supply 40,000 gallons daily. The private concessions, which had such disastrous consequences at Rome, soon began in Paris, and after the city had put the aqueduct in thorough repair in 1457, it granted the right of water supply to private persons so liberally, that the public fountain erected by Philip Augustus for general use, soon ran dry. In 1598 we find the right of water supply actually paid for in cash for the first time; the price was 35½ francs. Before then the concessions had been given, as in Rome, gratuitously, as a favor or reward. In 1606, Sully, King Henry IV.'s great minister, recognized the insufficiency of the existing works (which were only supplied by the two northern springs, Belleville and St. Gervais), for the wants of Paris. He therefore erected a wooden pumping machine, driven by a turbine, just above the Pont Neuf; this filled two cisterns erected on the piers of the bridge, from which the Louvre Palace and three public fountains were supplied. This wooden pump was so useful to the population during sundry sieges and periods of drought, that it was called the Good Samaritan, and was not removed until 1813. The aqueduct of Arcueil is more immediately connected with our subject; this was opened with much ceremony by Marie ed Medicis in 1624, after eleven years spent in construction. It brought down the water of sundry springs near Arcueil, and was at first only intended to supply the Luxemburg Palace, but afterwards delivered a sufficient quantity (217,000 gallons daily) for 12 public fountains. The aqueduct was only five miles long and cost 460,000 pounds French; about £40.000 sterling. But as the abuse of patronage by grants of water still continued to increase, the new works only palliated without removing the evil. According to a table dated 1669, which M. Maxime du Camp has found, Paris then had 35 public fountains which ought to have supplied 460,000 litres, or about 100,000 gallons daily, of spring water. But the private grants took away 60,000 gallons, so that only about ¾ of a gallon remained for each head of the population. As the town suffered fearfully every summer from this want of water, two great wooden pumping engines were erected on the Seine in 1671, which really raised 300,000 gallons a day out of the river, and in the course of the 18th century this quantity was somewhat increased. Several magnificent fountains decorated with statuary were erected in Louis XIV.'s reign; they were very handsome, but all had the same fault, of never supplying any water. This monarch also projected the execution of an aqueduct which was to surpass everything the Romans had ever constructed. He intended to bring water from the river Eure to Versailles and Paris, and proposed executing works of a total length of nearly 160 English miles. They were begun and even continued for some time; a row of arches about three miles long was commenced and many of the piers carried up to the springing; this work was to have been no less than 230 ft. high in the centre, and was to bear the name of Madame de Maintenon. It would have supplied Paris with about 25 million gallons daily of very middling water. For though Louis XIV. wished to rival the Roman aqueducts in magnificence and grandeur, neither he nor his ministers seemed to have perceived that the principal object of the Roman works, their very *raison d'etre*, was to supply pure and fresh water. Instead of drawing his supply from limpid springs the king intended to take it from the river Eure; far from guarding the aqueduct jealously from dust, vegetable matter, and similar impurities, he projected an open conduit exposed to the air; instead of protecting the water from frost and sun by covering it with a thick layer of earth, the supply would have become tepid in the summer, and occasionally frozen or interrupted altogether in the winter. After nearly 20 millions of francs had been spent on this huge work, and many hundred workmen collected by forced levies had perished, it was at last abandoned. The total estimate, which would no doubt have been exceeded, was 80 millions of francs.

(*To be continued.*)

THE CANADIAN PACIFIC RAILWAY.

Since the agitation in British Columbia in regard to the Canadian Pacific Railway at the time of Lord Dufferin's visit, the project has been re-discussed by Canadian papers, reviving considerable interest. The Toronto *Globe* of recent date, gives many interesting facts in regard to its proposed route, length, and estimated cost.

The route to be pursued so far as determined is, starting at Thunder Bay on Lake Superior, running northwesterly via Lake des Mille Lacs to English River, 113 miles, thence nearly due west with a slight curve to the north to Keenatin (Rat Portage, the northern end of the Lake of the Woods), 177 miles, thence with a slight dip to the south reaching the Red River at Selkirk, a little to the south of Lake Winnipeg. From Selkirk the line runs nearly due northwest for 200 miles, touching the southern extremity of Lake Winnipeg, by Shoal Lake, crossing Lake Manitoba at "The Narrows," thence trending southward reaches Livingston on Swan River, near Fort Pelly, 271 miles from Selkirk. From Livingston nearly due west, 196 miles, to the South Saskatchewan crossing, thence northwestly by the north Saskatchewan and Battle Valleys to Fort Edmonton, 516 miles from Livingston.

From Edmonton the line again crosses the N. Saskatchewan and then the Pembina and McLeod Rivers, its course being slightly north of west until it reaches the Arthabaska River, where it turns sharply to the south, reaching the Yellow Head Pass at an elevation of 3,200 feet, in Lat. 53°. From the Pass the route is due west to the Grand Fork of the Fraser River at Tete Janne Cache, then northwest by the Fraser Valley to Stewart River, 15 miles north of Fort George. From Edmonton to Yellow Head Pass is 283 miles and to Stewart River 260 miles farther or a total of 543 miles.

Stewart River is the most northerly point on the line. From thence to Waddington Harbor at the head of Bute Inlet, (the probable terminus) 288 miles, the route is nearly due south.

The nature of the work to be performed varies from the simplest grading to the most difficult rock excavation. The following table gives the classification of the work, and the distances of each kind as well as the total distances.

	Very Easy.	Easy.	Heavy.	Very Heavy.	Total.
Thunder Bay to Red River....	170	90	120	33	413
Red River to Livingston.....	200	71	...	..	271
Livingston to Edmonton.....	300	100	50	..	516
Edmonton to Yel. Head Pass.	60	150	73	..	283
Yellow Head Pass to Stewart River.....	75	155	30	..	260
Stewart River to Bute Inlet...	..	60	140	88	288
Total miles.	805	386	419	121	2,031

The cost of construction is estimated as follows: For Very Easy, $15,000 per mile; Easy, $20,000; Heavy, $37,000; Very Heavy, $80,000, or a total cost of $50,978,500; an average of $25,100 per mile

The above—exclusive of the Pembina Branch,—represents the trunk line to be completed, by the amended terms, by 1890. The whole scheme would stand as follows;

West of Thunder Bay, 2,031 miles.....	$50,978,500
East of Thunder Bay to French River, 620 miles at $40,000 per mile.....	24,800,000
Georgian Bay Branch, 80 miles.....	1,120,000
Pembina Branch, 89 miles.....	1,335,000
Subsidy to Canada Central, 120 miles.....	1,440,000
Total expense of the whole scheme.	$79,673,500

Up to the present time 227 miles of road, exclusive of Pembina Branch is under contract and in process of construction; viz., from Thunder Bay to English River, 113 miles, and from Keewatin (or Rat Portage on Lake of the Woods), to Selkirk, on Red River, 114 miles.

Between English River and Keewatin, 177 miles, the line is now actively locating and will be let at an early day. This link, from Thunder Bay to Red River, will be pushed to an early completion at a cost not exceeding $12,000,000, and will be of great immediate use in connecting the navigation of Lake Winnipeg and the Saskatchewan with that of Lake Superior. The telegraph is under contract from Thunder Bay to Fort George or Stewart River in British Columbia, a distance of 1,733 miles. The western terminus of the road is not yet definitely determined as the location is extremely difficult and not far enough advanced to give a choice of routes. The line will probably leave Bute Inlet by Homathco River, or Canyon, following it between 30 and 40 miles and then by the east branch. This will give a line of 108 ft. maximum grade to the mile with a level rest of ¼ mile on the ascent.

The northernmost point on the line is 54° 10′. Waddington Harbor at the head of Bute Inlet is in Lat. 51°. The highest Point is the Yellow Head Pass, 3,200 ft.

In the report of Sanford Fleming upon the Canadian Pacific Railway, (1874), many interesting facts are given in regard to climate, amount of snow, etc. Probably the severest weather will be experienced north of Lake Superior. Away from this lake and in the region from Red River to the Rocky mountains no excessive severity of weather or great snow fall will have to be provided for, and in the Rocky mountain region the weather will not be so severe as at Lake Superior.

No traffic that will result would warrant the construction of more than the Lake Superior and Red River section for many years, the wants of all parts of Manitoba and the Saskatchewan Valleys being rapidly supplied through the numerous navigable lakes and rivers of these regions. But other considerations will urge its comparatively early construction and from its low summits, light grades on all but the last 300 miles, and short distance from the Pacific to Montreal, it may hope to furnish a link in a Line of ocean steamers to New Zealand and Australia, with whose colonies Canada is now considering the establishment of extensive commercial relations. However, although a good portion of the country west of Manitoba, through which the proposed line is to run is essentially not tillable, there is still a very large area of tillable land which will be open to settlement and to which Canada may induce some of the hardier northern inhabitants of Europe to emigrate.

The completion of the Canadian Pacific is essential in making the most of what is at best a very hard climate and a very hard country in which to live, notwithstanding the remarkable isothermals of Cook & Co.

THE PACIFIC RAILWAY KINGDOM.

The St. Louis *Journal of Commerce*, in an editorial headed "Coming New Railway Kingdoms," after speaking of the kingdoms of the Atlantic, refers at some length to the kingdoms of the Pacific and its kings, and laments the lack of enterprise of St. Louis, which should allow San Francisco to obtain control of all the commerce of the Pacific and of the coast of Mexico and South America as far south as Patagonia and even around Cape Horn to Europe. It says:

"Pacific enterprise has steamships to the East Indies and Australia, and imports and exports to supply other world's markets and one of these days her ships will be coming through a hole in the Isthmus.

"This railroad kingdom already extends down the valley past Los Angeles, and the cheap Chinese laborers are at work away eastward, near to the Colorado. The money comes abundantly; only a few months ago we saw a mortgage of $20,000,000 to Messrs. Flood and O'Brien recorded at Almeda, and the road is promised complete to Arizona next January. Nor is this all. A quiet power was a year or more ago sent down to Mexico and a survey made, and one of these enormous grants of land obtained from the Mexican Government, for a railroad from Guaymas up the Valley of Mexico to Tucson, in Arizona, where it is to meet the Southern Pacific. Now we learn that Flood and O'Brien own this grant. Guaymas is from St. Louis the nearest point on the Pacific coast, and in the most direct route to Japan and China."

It goes on to say—"This is the building up of the kingdom," and asks if it is not worth while "to make an effort to divide with it the spoils of Mexican commerce and the Rocky Mountain mines," and ends with an appeal to the people of St. Louis to assist Col. Scott in forwarding "enterprises to the building of a great competing kingdom which shall direct Mexican and East Indian commerce to our doors." Gov. Sanford of California in a recent address uses the following language which seems to be the text of the *Journal of Commerce*' editorial:

"We are quietly but resolutely expending our every exertion to build the Southern Pacific Railroad. We are toiling for the greatest prize that this continent affords. The people of California and the people of San Francisco have no appreciation of the splendid trade that we are opening up for them, nor of the magnificent destiny which awaits this city when we shall have brought to its doors the vast trade of Arizona, New Mexico, Sonora, Chihuahua and the Valley of Mexico—for it is nothing less than this that we are striving for. * * The people of San Francisco will never appreciate how great a danger menaced them, nor how great a peril they escaped. Had Tom Scott built his road to the Pacific he would have taken from us our best prospective traffic and carried it East. He would have reached over to our own borders and carried our trade; he would have given San Francisco a blow from which she would have never recovered."

There is no doubt but that the main object of California in forcing her Southern Pacific southward is not so much to obtain an eastern connection but to strike via Tucson, in Arizona and thence southward through the state of Sonora to the magnificent harbor of Guymas on the Gulf of California, whence the trade of the west coast of Mexico will be largely controlled. On its way it will open up a mineral region in northwestern Mexico, known to be immensely rich.

It is admitted that the Southern Pacific, as completed to Fort Yuma by Jan. 1, 1877, can never be expected to pay for a long time, unless coupled with a project similar to the one outlined. There is, however, another object. All the roads under the name of Southern Pacific have been built by men interested in or controlling Central Pacific, and the building of the road a certain distance eastward will forestall any independent line to the Pacific for many years, and thus, in fact, should the road be built from Texas westward its western end would be practically under the control of the same organization as the Central Pacific, so that the benefits to be expected from a competing line would be wholly illusory, although there can be no doubt of the benefits to the territory termed the southwestern states. It would seem that such an extent of railway as the Southern Pacific has already built through a sparsely settled and not always fertile country, without land grant is a severe criticism on the moral purpose of an enterprise which can only build the eastern end (Texas Pacific) except by lobbying a land grant and subsidy through Congress. If the road is a necessity, or warranted by the prospects of traffic, it will be built, through the same energy and long-headedness that our Pacific brethren are now pushing forward their southern and southeastern lines.

CIVIL ENGINEERS' CLUB OF THE NORTHWEST.

The regular meeting of the Club was held in the Sherman House Oct. 3d. President Chesbrough in the chair with members present, Chas. Paine, Past President Morehouse, Greeley, French, Hjortzberg, Green, Cleveland, Cooley, Wolcott, W. C. Clarke, Booth, Durham, Thomas, Gleason, Case and Frost. After the approval of the minutes of last meeting the Secretary announced the following candidates for membership as having been nominated; H. C. Nutt, C. E., Chas. A. Clinton, Asst. Eng. C. & A. R. R.; C. H. Hudson, Asst. Gen. Supt. C. B. & Q. R. R.; W. D. Clark, C. E., City Engineer Springfield, Ill. Donations of pamphlets on the "Improvement of the mouth of the Mississippi River," by E. L. Corthell, Chief Asst, Engineer South Pass Jetty Works, were received.

Chas. Paine, Past President, then read the paper for the evening, entitled "*A French Railway Charter*," which was listened to with great interest by the society, and afterwards briefly discussed by Messrs. Paine, Chesbrough, Greeley, Morehouse, Hjortzberg and Clarke. The paper was quite too voluminous for publication in ENGINEERING NEWS, and an abstract could not do it justice. It will most likely be published shortly in one of the railway papers and afterwards for distribution among the members of the Club. The paper was a free translation by Mr. Paine, of the model from which, with alterations to suit the exigencies of each case, the Charters for French Railways are drawn, and is particularly illustrative of the very paternal character of that government. The date of the original from which the translation is made is as recent as 1872.

Mr. H. W. S. Cleveland made a partial report of the proposed arrangements for testing the merits of the Divining Rod, by Chas. Latimer, C. E.

The meeting then adjourned after which some time was spent in social conversation and in a minute examination of the very fine map of soundings taken on Sept. 11th and 12th at South Pass, and referred to in ENGINEERING NEWS of Sept. 30th. A great deal of interest in this map was exhibited by everybody present, and

exhibited the interest taken in the jetty question by some of our leading engineers. At the final close of the meeting the map was taken home for more careful examination by the Chief Engineer of one of our leading railways, and we take this opportunity to invite any person interested in South Pass Jetty matters to call and examine this map, and also any other documents relating to this important work, at the office of ENGINEERING NEWS.

We expect to be kept informed as to the latest developments in the experiments in progress at the mouth of the Mississippi, and as we feel certain that the profession generally is watching them closely, so it may be well for them to know where all the literature on both sides may be found easy of access.

BY reason of a mishap of the Lithographer in making a transfer, we are obliged to hold our map of Hell Gate over one week more.

ONE of the most important duties of an engineer on a public work, is to draw the specifications, and on their general correctness and comprehensiveness of detail, coupled with the proposal and contract, largely depends the success of the work for which they are drawn, and the freedom from dispute in regard to the proper execu- of the same, and the heading off of a numerous class of extra charges which even contractors delight to indulge in at every inadvertent loop-hole, or ambiguous construction of language in said papers. Forms of specifications, proposals and contracts, are seldom published by engineering papers, and for that reason, to the young engineer and often to the fathers of the profession they are very valuable, not for their present interest but for reference as models when the engineer is called upon similar work. In July we published the specifications for the Fullerton Avenue Conduit now being constructed in this city. In our present number we commence on the specifications for the "Improving and Constructing Riverside Avenue" in the city of New York. This will be followed by the specifications for the construction of a sewer in the same city. From time to time we shall publish other specifications for important public works, or important general classes of work. In the present instance we take pleasure in acknowledging our indebtedness to J. J. R. Croes, C. E., Department of Public Parks, New York City, and we shall be happy to make similar acknowledgments to others who shall do us a like favor. The specification which we publish this week was prepared by John Bogart, Supt. Eng. of City Parks, and the work is to be under his charge.

Colleges, and Engineering Instruments.

Among the many curious articles one is apt to meet with, here and there, while perambulating the great Centennial Exposition at Philadelphia, none attracted more our attention than a very rudely constructed Plane-table, with alidade made *entirely* of wood, and said to cost $15., but in reality a worthless toy, no attention having been paid to proper proportions, durability, strength or steadiness.

As this is intended for use and exhibited by one of our leading educational institutions, well known for fitting students for the engineering profession, its real purport is not at once apparent, were it not for the price attached to it, which conveys the idea to the mind, that it is constructed with a view to saving money. How a student can practice the A B C, and acquire an accurate knowledge of the requirements of topographical engineering with such an instrument as this—save executing a *finely drawn* sketch of the topography of the country with no attempt at accuracy—is incomprehensible to all who have a sincere wish for a progressive step toward the more general adoption of the Plane-table.

With the same propriety this institution constructed a wooden Plane-table, it might construct a Transit of wood, and endeavor to impress the students with the importance of accuracy required in triangulation.

This case of saving money at the wrong end, and at the expense of imparting knowledge in a thorough manner, is only one illustration in many where our American colleges are sadly deficient compared with their sister institutions of Europe. Our colleges erect models of edifices, but have *no* money for a proper outfit of instruments and apparatus; and are obliged to pay scanty salaries to their professors, who in turn, are obliged to direct their attention to private interests. The consequence of all this is, that our colleges—*with honorable exceptions*—do not use the best surveying instruments, but, as a rule, are satisfied with what an engineer of good standing would discard as unworthy of his profession. The truth is that it is the almost universal practice for professors of smaller colleges to import their engineering instruments from Europe, to save a few dollars; and everybody conversant with this subject will agree and testify to their great inferiority to our home manufacture, and as not at all adapted to the wants of the American engineer; no more, in fact, than an imported hand-lathe of old pattern, would meet the requirements of the average American machinist.

The American exhibit of this class of instruments at the Centennial, compared with the foreign, will substantiate all that has been said above, though it might be argued that the most respectable foreign manufacturers are not represented, to which must be replied, that the same exists with regard to our home manufacturers. —[Communicated.] B. B.

[With the unwarranted assertion contained in the closing lines of the above communication the Editor of this Journal does not agree. We see no reason why any manufacturers should consider obscurity the only passport to "respectability."]

The Dimensions of Narrow Gauge Railroads.

BY GEORGE PAUL, C. E.

If it is desirable to determine the tractive force of the cylinders of a locomotive, the rule is to multiply the effective pressure per square inch by the square of the diameter, and that product by the length of stroke, and divide the whole by the diameter of drivers in inches.

Example: Effective pressure 102 pounds, diameter of cylinder 10 inches, length of stroke 16 inches, diameter of driver 40 inches $102\times10\times10\times16\ 40=4{,}080$ pounds.

It is customary to allow four-fifths of the boiler pressure for effective pressure upon piston.

The speed of 12 miles an hour is the greatest that could be attained upon a grade of 52.8 feet per mile; but should the grade be less than that, as it most always is upon a great portion of the road, then the speed could be increased. Where the grade is 30 feet, the resistance due to gravity is $30+2.64=11.36$ pounds. Subtract this from total resistance, and we have resistance due to speed and friction. To find the speed, subtract resistance due to gravity and friction, then by reverse of rule, we find (multiply by 171 and extract square root equals speed in miles per hour) $27.84+(7+11.36)=9.48$: $\sqrt{9.48\times171}=40\frac{1}{4}$ miles per hour, which could be attained upon a grade of 30 feet per mile with no more exertion than that required to produce a speed of 12 miles per hour when the grade was 52.8 per mile.

For freighting purposes it might not be necessary to maintain a speed of over 20 miles per hour; and if the grade of 52.8 was the maximum, and only occurred at long intervals, then the capacity to produce a speed of 6 or 8 miles per hour upon that grade would be sufficient for the speed required. When upon the lower grades, if, under these circumstances, the speed was 8 miles per hour, the heating surface, grate area and cylinder capacity would only require two-thirds the amount necessary for a speed of 12 miles. But the weight upon the drivers should be the same, inasmuch as the tractive force is not diminished with the speed.

Of the locomotives in common use there may be said to be two divisions or classes: First, the tank engine which carries all the fuel and water within or upon its own frame. This engine is generally so constructed as to permit the additional weight of fuel and water being used for increasing the adhesion of the wheels or drivers; but inasmuch as it is constantly varying, as these materials are used or added, it cannot be relied upon; and this class is generally used for switching engines, and engines of short run, especially in this country. The locomotives built by Fairlie are of this class. Their general design is such that they can be constructed so as to have sufficient adhesion when light, and not to bear with an under-weight upon the rail when the tanks are filled. This is owing to the fact that so many driving wheels are admissable. By his designs twice as many can be used as upon the ordinary locomotive. The second class spoken of are those having separate tender to carry their fuel and water. This class is in more common use than the first.

There are many varieties of the above classes, the variation being often in the manner of placing the cylinders, whether inside or outside, and in the number of driving wheels, and whether trucks precede them or not.

The number of drivers in use varies from two to ten upon the roads of this country, and the locomotive having four drivers, with trucks consisting of four wheels preceding, is the one in most common use where speed is required, the duties of the trucks being to guide the forward end of the machine and keep it from leaving the track, its construction being such as to permit of adjusting itself to the track more readily than the drivers. These engines have about two-thirds of their weight upon the drivers and one-third upon the trucks.

The locomotives having six to eight drivers have been in use for many years as freight engines, especially upon roads having steep grades and large quantities of freight to move, their construction being such that the whole of their weight is utilised for adhesion.

The type of locomotive known as the "Mogul," having one pair of leading wheels, instead of two in trucks, is said to give very good satisfaction as freight engines. The fact that the cost of a locomotive is generally governed by its weight, renders it advisable to use the class designated as freight locomotives where only low rates of speed are required, because it is not advisable to pay for the extra weight necessary to obtain high rates of speed.

The Opening-up of Africa.

It is within the bounds of easy probability that before the lapse of many years the followers of the ubiquitous Cook will astonish the natives of the *Terra Incognita* which has so long been a blank on the maps of Central Africa. The grand tour in the days of our grandfathers ended at Rome or Madrid; now the familiar Tweed jacket is not unknown at the North Cape, in the Arabian Desert, and the northern skirts of Sahara. The conquests of the Khedive, and the missionary settlements on the lake sources of the Nile must, before long, introduce British holiday-makers to regions which have remained mysterious and unknown to the European nations from the dawn of history; and westward, the fine country fertilized by the head-waters of the Congo, rich in mineral as well as vegetable productions, may soon be as familiar to us as the Highlands of Scotland were when their kilted inhabitants followed the two Pretenders in their attempts to recover their hereditary crown. While Gordon Pasha is extending the conquests of his predecessors along the course of the Father of Waters, Mr. Donald Mackenzie, whose ancestor, mayhap, fought for the Old or the Young Chevalier, is engaged, so far successfully, in pioneering the march of civilization to Timbuctoo. The latest accounts represent him as having discovered the mouth of the ancient inland sea, the bed of which now exists as a depression on the southern margin of the Great Desert. The conditions of his scheme appear to be, so far as the exploration has gone, unexpectedly favorable. The depression, at its commencement, is about 330 feet below the mean sea level, and the bar excluding the waters of the Atlantic only about a-mile-and-a-half in length by about 300 yards wide, so that the engineering difficulties that exist in the way of making dry land again sea, and exchanging steam communication for the ship of the desert, will be easily surmounted. [*Iron*, viii, 259.]

NOTES.

One of the paper car wheels of the American Paper Car Wheel Co., of Hudson, N. Y., has run under a Pullman car 312,900 miles without the tire being turned.

The largest lantern ever made is soon to be erected at Galley Head, near Cork, Ireland. It is a flash light, consuming 1600 cubic feet of gas per hour and equal in power to 2,000,000 candles.

On Sept. 28th the workmen of the Baldwin Locomotive Works turned out in a general gala day, in celebration of the near completion of the 4,000th locomotive built by that company since its establishment in 1831.

On Estimating the Illuminating Power of Coal Gas.

BY WILLIAM SUGG, Assoc. Inst. C. E.

[A paper read before the Institution of Civil Engineers.]

(*Continued from page* 318.)

Mr. J. N. Douglass considered there must be some mistake on Mr. Vernon Harcourt's part as to the power of the flame being due to its length. He did not think Mr. Sugg could mean that a flame 3 inches long, giving a light equal to sixteen candles, could not be shortened without impairing its intensity. In lighthouse burners it was desirable to confine the length of the flame, and indeed to obtain a flame nearly spherical, for the purpose of utilising it more completely by the optical apparatus; and he had found that such a flame as that of the Sugg burner could be reduced to less than half its length, still retaining the same illuminating power. Nearly three years ago he had to apply, for the first time, Argand gas burners in the focus of parabolic reflectors for the Caistor leading lights at Yarmouth. He tried several gas burners, and among them Sugg's London Argand burner, which he found to be the best; but still the flame of this burner was too long for the purpose, it being about 1 inch in diameter and 3 inches in length. He therefore made some experiments, basing them upon the principles adopted in the improved "Trinity House" oil burners for obtaining perfect combustion and the required form of flame. He succeeded in arriving at the desired result, and also in attaining nearly the same economy in combustion as had been found in the improved "Trinity House" oil burners. On comparing the new one with the Sugg burner of the same dimensions and number of holes, the two consuming the same quantity of gas, viz., 5 cubic feet per hour, he obtained nearly 33 per cent. more light with the former. He submitted the burner to the Elder Brethren of the Trinity House and to their scientific adviser, Dr. Tyndall, and took it to Mr. Sugg, who tested it with the same results, and who afterwards made the burners for the Caistor lights, which had been in use ever since. Mr. Sugg had since modified his London burner somewhat in accordance with the one referred to. The original London burner had a cone, but no central deflector or button, and there was no air passage between the cone and the glass chimney. The improved burner was the most perfect Argand burner he had yet met with for general purposes. The use of inner and outer deflectors to Argand gas and oil lamps had been patented by Mr. W. Wilkins, in 1862–3. By the application of these deflectors, and other improvements to oil burners, he had found that the present "Trinity House" improved lighthouse burners, which were adapted for burning either animal, vegetable, or mineral oils, when consuming colza oil the standard had been raised 39.38 per cent., *i. e.*, the illuminating power had been increased 22 per cent., with a reduction in the consumption of oil of 17.38 per cent. If considered economically, irrespective of the increased power per burner, a saving of oil had been effected of 32.47 per cent. These results were sufficient to show the importance of an efficient gas or oil burner. At the same time it could not be too clearly kept in view, in adopting a standard burner for estimating the illuminating power of coal gas, that as the efficiency of such a burner was improved the specified candle power of coal gas would be raised *pro rata*, otherwise the benefit to be derived by such improvements would fall to the gas companies instead of to the public.

Professor W. G. Adams observed that it had been pretty generally admitted, that the means of estimating the illuminating power of coal gas was in an unsatisfactory state. This was true of the power of measuring as well as of the power of producing the illuminating power; and all existing photometers were defective in that they relied on comparisons made by the eye of the observer between illuminations from two distinct sources. Attention had been drawn to another method of measuring the intensity of light by means of the radiometer, invented by Mr. Crookes, where the action of light and heat falling on a pitch disc, which was blackened on one side, caused it to rotate, thus establishing a direct relation between two of the physical forces, radiant heat or light and motion. He wished to draw attention to the direct relation between two other of the physical forces, light and electricity, which was established by Mr. Willoughby Smith three years ago; who discovered that when light fell upon a piece of crystalline selenium which was in an electric circuit with a battery and galvanometer, the electrical resistance of the selenium was diminished by the exposure. During the last two years Prof. Adams had been experimenting on this subject, and his results had been laid before the Royal Society. They seemed to show that those rays of the spectrum which produced light were the rays to which chiefly, if not entirely, the change of electrical resistance was due. The dark heat rays produced little or no effect on the electrical resistance of the selenium. He had inclosed pieces of crystalline selenium in a box with a lid to exclude the light, the bottom of the box being made of ebonite, into which were fixed the binding screws for supporting the selenium and making contact with the electrical circuit. The resistence of the selenium was balanced, before exposure, by a high resistance formed of a thick blacklead pencil mark on ebonite, which was varnished with a thin coating of shellac varnish. The spot of light of a delicate reflecting galvanometer was then at the zero of the scale. On opening the lid of the box the resistance of the selenium was diminished, and the spot of light travelled along the scale. Several series of experiments had been made to determine the relation between the intensity of the light and the change of resistance which it produced. The intensities of different sources of light had been compared by means of Bunsen's photometer, and the change due to the exposure to these sources had been determined by the throw of the galvanometer needle, the duration of each exposure being ten seconds. In one series of experiments, the action of a single candle placed at different distances from the selenium had been measured, and compared with the action of an Argand lamp of the illuminating power of sixteen candles. The following deflections of the needle were obtained:

	At ¼ metre.	½ metre.	1 metre.	2 metres.
With the Argand lamp ..	170	83	39	
With one candle.....	82	40	18	8

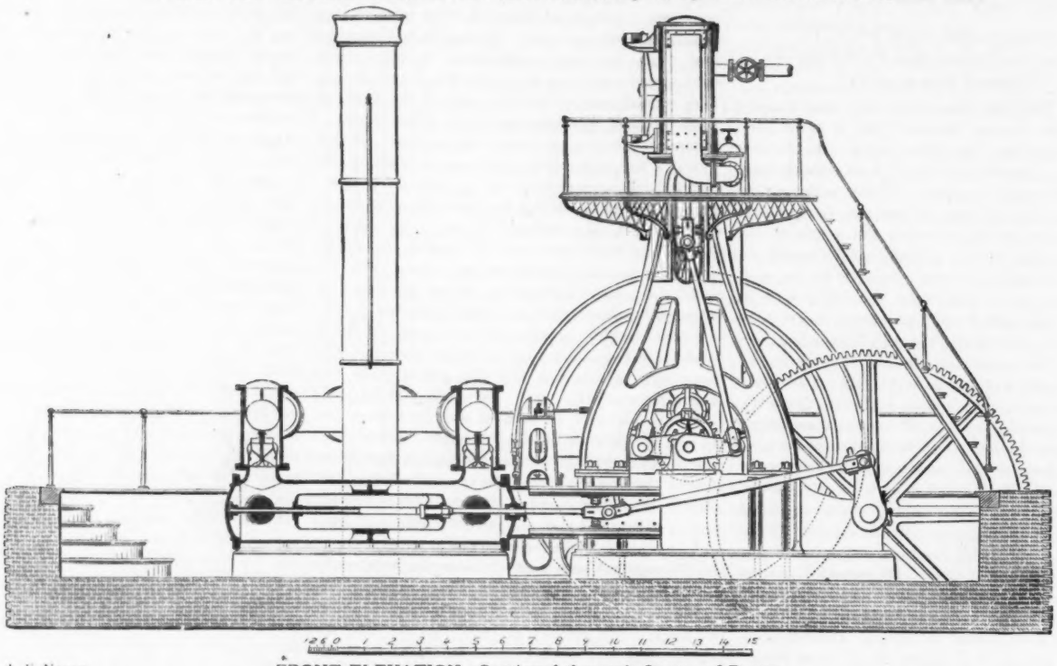
In another series of experiments, with a different piece of selenium exposed to the light of a candle at varying distances, the results were:

	At ¼ metre.	½ metre.	1 metre.
With one candle.....	45	25	15
" " " -----	40	20	10

The results obtained showed that the action of the light during exposure for ten seconds, as indicated by the throw of the galvanometer needle, was inversely as the distance of the source of light, *i. e.*, directly as the square root of the illuminating power. Hence with the selenium photometer, when two sources of light at different distances produced the same change of resistance in the selenium, their illuminating powers were directly as the squares of their distances from the selenium. Not only might the relative illuminating powers of two sources of light be compared by this photometer, but a direct relation might be obtained between the illuminating power of the light and the change of resistance produced by it in a given piece of crystalline selenium at a given temperature.

Mr. Sugg, in reply, said he had placed on the table the jet photometer, to illustrate the difference between it and the Illuminating Power Meter, and that it might be seen how far the results corresponded in the manner mentioned by Mr. Vernon Harcourt. Dr. Letheby had referred to the variations in the illuminating power of the standard sperm candles. This subject had already been brought before the Institution in a paper by Mr. T. N. Kirkham, M. Inst. C. E., in which the results were given of a great number of those experiments—especially of one series made in conjunction with Dr. Odling, and in which he found there was a difference ranging as high as five candles in the estimation of 14-candle gas. That arose in this manner: Dr. Odling purchased the candles in different places, and the difference in their manufacture was sufficient to cause the wide variation of five candles. Dr. Odling was quite satisfied at that time that the candles were not a reliable tandard. By making them carefully that error had been mitigated; but it was still open to inspectors testing gas throughout the kingdom, except those testing under the Gas Referees, to buy their candles wherever they liked; and if those candles were adulterated with paraffin or stearine, there was sure to be a difference in the illuminating power. The object of the illuminating power of the meter was principally to have a check upon the candles; and he did not propose, as Dr. Letheby seemed to imagine, to do away with the ordinary photometer, his standard burner, which would always give a light equal to sixteen sperm candles, so as to check the candles if they did not burn properly. He had made a number of experiments with these candles in comparison with the standard burner, and found that the candles gave a different result, varying from 15 to 17; whereas the flame had always been supplied by the same quality of gas, and therefore there could be no variation. With respect to the Birmingham burner, Dr. Letheby remarked that, probably, now that the authorities had taken the matter of gas into their own hands, they would regret the adoption of the Birmingham standard burner for the purposes of testing the standard gas. At the present moment they had escaped from that difficulty by adopting the London standard burner; but in other cases where the Birmingham burner had been adopted they would, no doubt, have to contend with the difficulty of getting bad results. The burner placed upon the meter was an ordinary consumer's burner, and not specially made for the purpose of the photometer. Mr. Vernon Harcourt thought there would be a difficulty in reading the exact height by inches, because of inequalities in the height of the flame. Supposing a burner were made expressly for photometric purposes, no doubt the flame could be kept perfectly level on the top, but the slight variations in that standard burner did not make any appreciable difference. Several members of the Institution had tried the regulation of the flame themselves, and the only difference was about half a candle, not a great difference when it was remembered that they had never seen the instrument before. Mr. Vernon Harcourt had also spoken of the more easy method of reading the height with the jet-photometer. This instrument showed the illuminating power of the gas in a manner somewhat similar to the Illuminating Power Meter, namely, by the height of the flame. If the gas was rich, the flame went up higher; and if poor, the flame was low. By regulating always to one height of flame, and reading off the pressure required to give that height of flame, a correct estimate could be formed of the illuminating power of the gas. There was only one difficulty, which he hoped to remove, and that was the difficulty of the standard burner. For every quality of gas at the present moment a different standard burner was required; and as they all differed among themselves, it was difficult to fix the readings of the jet-photometer to any particular point which would be universally correct; for if it was correct for one standard burner, it was sure to be wrong for another. That difficulty was again complicated, because with gas beyond twenty candles the Argand burner was replaced by a burner which gave a flat flame, and the flat-flamed burner gave a higher result for the higher illuminating power of the gases than it ought to. Up to 30-candle gas it made a difference of about three candles. That difficulty did not exist with the Illuminating Power Meter, because it was adapted for gas from twelve candles to thirty-two candles; and although with 35-candle gas there seemed to be a little difference, it depended upon the chimney placed over the flame. If a long chimney was put on, which favoured the richer gas and deteriorated the poorer, it would give the benefit to the richer gas; but by putting a chimney suitable to both kinds, the illuminating power of the burner could be made exactly the same, whether 12- or 35-candle gas. Dr. Pole mentioned that, according to law, official testing must be made with 5 cubic feet of gas; but it was known that for a long time that had not been complied with. In the case of Birmingham, in particular, if the gas was over fourteen candles, it used to flare over the chimney, and it therefore became necessary to reduce the quantity; and so also in many other places. In London it was not so done, because the Gas Referees had made a provision to avoid it. They said that when the gas was so rich that it tailed over the top of the chimney, a still longer chimney should be put on. If that was done in London, it was just as easy to do it in other places, as Birmingham, where the burners would not consume the proper quantity of gas. His proposition was to provide one standard burner for all qualities of gas, by which means all difficulty was avoided, simply by reducing the quantity of gas used in accordance with its richness; and so correctly and proportionately to estimate the quality of the gas burned. With respect to the radiometer, there appeared to be some difficulty in its application to gas photometrical purposes. It certainly went round fastest with the hottest burner; and it would go round as fast with a heated poker as it would with the burner. No doubt the movement was as much affected by heat as by light; but with one standard burner and one height of flame, if the radiometer was placed at a sufficient distance, that difficulty might be got over to a great extent. Also if the number of revolutions could be reduced, it might be possible to check the accuracy of the burner, and so have another check upon the sperm candle, or perhaps eventually do without sperm candles at all.

PUMPING ENGINE FOR THE PROVIDENCE, R. I., WATER-WORKS.



A. F. Nagle. FRONT ELEVATION.—Sectional through Centre of Pump.

Pumping Engine for the High Service Water Supply.

Designed By A. F. Nagle, M. E.

Constructed by the Providence Steam Engine Company.

In accordance with the specifications of the chief engineer of the Providence water works, J. Herbert Shedd, C. E., there was completed and tested in December last, a second, or duplicate engine for the high service in this city. The first engine for the perfomance of the same service, under the same conditions, had been designed and built by Mr. Geo. H. Corliss, in 1872-'3, and had been running nearly two years; and this second engine was provided as a substitue in case of need or preference.

The contract for the engine stipulated that "the engine is to be capable of raising with ease five millions of gallons of water in twenty-four hours to a height of one hundred and twenty feet above (the low water level of supply to the pumps) under a possibly varying (level of supply of forty feet); is to work smoothly under the above conditions (as to lift of water), and also when (raising) but three hundred and fifty thousand gallons in twenty-four hours (under like conditions as to lift of water); is to be attached to the suction and force mains now located in that station; is to pump directly into the distributing pipes; and is to perform a duty of seventy-five million foot pounds per hundred pounds of coal."

It will be noticed that these contract requirements of capability, apparently call for the greatest and least velocities of the engine, to vary as fourteen to one, and the greatest and least performance of the engine, to vary as twenty-one to one. These demands when applied to any continuous movement steam engine are sufficiently onerous, and it may be questioned if the accomplishment is a possible one; but even these apparent demands are exaggerated when the condition of direct connection to the distributing pipes is included with the daily limit of supply and the possible varying head of resistance.

The capability to raise five millions of gallons with ease in twenty-four hours, means that at times the engine shall run at a rate—for some minutes—which would supply, if continued, six millions in twenty-four hours, while the delivery of three hundred and fifty thousand gallons in the distributing service in any twenty-four hours could hardly call for a speed of engine at midnight, for instance, that would exceed the rate of ninety thousand gallons, if continued the whole time. These figures give the variation of speed of engine between the greatest and least requirements as nearly seventy to one; and the variation of greatest and least *performance* as one hundred to one.

Without entering into the question of the possibility of accomplishment, in this notice, it will only be said that he engine did not fulfil the specifications (neither did the Corliss engine) to the letter of the contract. But by means of a relief valve, a quantity (not stated) of water, which, it may be assumed, was considerably in excess of the three hundred and fifty thousand gallons in the twenty-four hours, was permitted to escape from the distributing pipes, (under the resistence of flow through the aperture of this valve, and discharge into the supply mains), to be pumped over. In this manner the necessary constancy of resistance was made to accompanying extreme variations of demand, so that when the requirement was exceedingly small, the regular work provided by the "relief valve" would be sufficient to keep the engine in motion with comparative smoothness.

This evasion of the terms of the contract being allowed, the testimony of the experts (Chas. Hermany, C. E., J. B. Francis, C. E., and Prof. Chauncey Whitaker) shows that the engine would command the exigencies of the service for which it was intended, which really are the maximum supply of five millions of gallons in twenty-four hours, with a minimum supply of whatever may be abstracted from the water pipes at any time. And this irregular demand was met even to the maintenance of pressure when the fire hydrants of the district were put in use suddenly and without communication with those employed about and running the engine.

The usual stipulations as to quality of material, workmanship, strength of parts, and changes of plan, delivery of material, advances of money during construction, protection from liens on work or material, etc., follow in due course in the contract.

With these clauses, there is one which has become usual with some engineers, whereby the contractor is made to defend the city, its officers and agents, against all patent claims or demand, under a bond of indemnity. If this condition bears the restricted sense of subjecting the contractor to make payment for the use of anything which may be patented in the construction of the work only, limiting the obligation to the profit he may derive as a constructor from such use, as against the use of well known unpatented devices, it is open to no reasonable objection; but if it means that the contractor is to bargain to make himself liable for the value of all or any patented arrangements, whereof the city of Providence may have had the advantage or profit in use, and which patented arrangements the city officers have procured to be made for the city, then the condition is onerous and unfair in the extreme. Under this last rendering the unfortunate contractor would be required to defend, knight errant fashion, against all comers, while the city authorities can foster, encourage or default in the litigation, wherein he may be liable to serious loss, without having the least valuable consideration for his liability.

The engine was to have a duty, as tested by a board of three experts, of "at least seventy-five millions of foot pounds per one hundred pounds of coal, when delivering two million gallons in twenty-four hours against a head of one hundred feet." "The conditions of the trial are to be similar to those adopted in the trial of the Lynn Pumping Engine, in December, 1873."

The boilers and appurtenances, together with the engine foundation, were embraced in the terms of proposals, and were part of the contract.

The price for the whole was fifty-four thousand dollars, conditioned on performance as above, with a requirement to remove the engine and all, if the stipulations of the contract were not met.

The essential feature in the Lynn trial was the establishment of some value of fuel by the use of selected and picked anthracite coal, that would yield about 10 per cent. only of ashes, or 90 per cent. of combustibles.

The test of this engine has not been yet reported in detail, but a summary or result is stated by the experts: "The engine pumped at the rate of a little more than two million (2,000,000) gallons per twenty-four hours by wire measurement, and made a duty of 84,637,245 foot pounds per hundred pounds of coal consumed.

"This work and duty were obtained during a continuous run of fifty-six hours, fifty-one (51) of which were selected by omitting some hours at the beginning, and some at the end of the trial, for which fifty-one hours the calculation is made; all the coal put into the furnace was charged to the engine, and no deduction made for clinkers, ashes or cinders." *

On the basis of the report of the experts the engine was accepted, and a settlement made with the city, subject to the guarantee of the contract of "the strength as well as the quality of the materials and workmanship of all the parts, and the making good on the part of the contractor, at his cost, all outlays or injuries caused by defects in the same during first twelve months of working the engine," a responsibility which (under the circumstances of the engine, with its duplicate to be operated if it is thought proper) may not be relieved for the next twelve years.

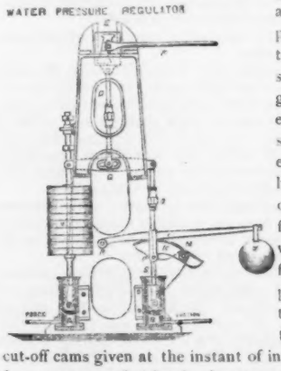
The engine, which has been found to conform to these stringent requirements, is shown in elevation and cross section on the accompanying cuts. It is of the vertical, double over head cylinder, compound type, usual for propeller engines, with a double crank shaft, and opposite connected cranks. The main shaft is led off on the high pressure side, and carries a fly wheel of considerable weight, and has behind the back bearing a half-stroke

* If the whole time had been taken, the result would have been a little *more* favorable.

crank, which gives motion to the piston of the air pump, and preserves the vacuum in a jet condenser. On the main shaft is a pinion which communicates motion to the pumps through a gear wheel upon a second crank shaft. The pinion and gear bear the relation to each other of one to five. There are two horizontal pumps, one on each side of the bed plate of the vertical engine, driven by right angle cranks at the rate of one stroke of the two pumps to each five strokes of the engine. The pump valves are double beat, there being one suction and one delivery valve at each end of each pump. The high pressure cylinder is eleven inches, and the low pressure one is nineteen inches in diameter; the stroke is three and a half ft. Both cylinders are steam jacketed by live steam.

The admission and emission of steam is effected by three separate valves at each end of the two cylinders, which are moved on their seats by sliding cams, having a vibratory action. These cams are worked, although not directly, by a single eccentric; and by high pressure cylinder; the second valve serves for the exhaust valve for the high pressure and an admission valve for the low pressure cylinder; while the third valve is the exhaust valve from the low pressure cylinder to the condenser. The flow of steam in the high pressure cylinder being controlled by a governor, which regulates the motion of an auxiliary cut-off valve, on the back of the steam valve.

The automatic arrangement for adapting the speed of the engine to the varying requirements and conditions of the service, consists of two cylinders, into one of which water is admitted from the suction side, and into the other from the dilevery side. The varying pressures of water on these cylinders, resulting from the increase or decrease of the supply on the one hand, as compared with that in the delivery on the other—so acts on the fulcrum of the connecting lever between the two cylinders as to operate the cut-off, and adapt the supply of steam and the consequent speed of the engines to the then existing circumstances. This governing apparatus has not operated quite as successfully as could be wished, as the effective power for performance of the work of moving the position of the cut-off cams given at the instant of increase of pressure from 119 to 120 feet head of water, is scarcely large enough to be available, and the friction resistance of the plungers is too great a disturbance to the delicacy of action of the pressure.



The fly-wheel is thirteen feet in diameter and weighs eleven tons. As the speed of the fly-wheel is five times as great as that of the pump shaft, the effective value of momentum in preserving the uniform velocity of the engine, is twenty-five times that which it otherwise would have been.

The pumps are seventeen inches in diameter, and have a stroke of four feet. The consequent displacement of the two pumps is 271,440 gallons each twenty-four hours; whenever a double stroke (or revolution) of the *pair* of pumps is made per minute. The requisite *average* speed for the specified quantities to be delivered was, therefore (without allowing for loss by leakage), eighteen and two-tenths revolutions of the pump shaft for the least quantities, per minute. The corresponding velocities of the engine were ninety-one revolutions, and six and a half revolutions per minute. The experts limit their report as to smoothly running clause to "It did run smoothly while performing this work," *i. e.* 2,000,000 gallons, or thirty-six and four tenths revolutions of the engine per minute.

On the whole this engine of the high service at Providence can be confidently accepted as one of the most satisfactory solutions of the problem of the direct water supply to a distributing service, without the accompaniment of reservoir or stand pipe.

The boilers provided with the engine were two in number, each with about twenty square feet of grate. They are of the ordinary fire box, flue-and-top tubular type, of American river or coast steamers of small size. As might be supposed, they are not very self acting to meet vicissitudes of requirement of 100 to 1, nor very economical in evaporative effect of fuel for slow rates of combustion.

A statement made in the Providence *Evening Bulletin*, Aug. 3rd, is the authority for the following comparison of performance in actual service between the two engines.

For the week ending July 23d, 1875, the first engine pumped 3,320,055 gallons of water, and consumed 26-610 pounds of coal.

∴ This performance is equivalent, if the water was lifted to full pressure from the least level of water supply (an empty reservoir, or 120 feet water column pressure), to 12,482,000 duty, or if the water was lifted only 80 feet heigh, 8,322,000 duty, or water lifted one foot high by 100 lbs. of coal.

For the four weeks ending the same date, the same engine pumped 13,999,095 gallons of water, and consumed 110,262 pounds of coal.

∴ This performance is equivalent to 12,693,000 duty for the high lift or 8,642,000 duty for the low lift.

The corresponding time of year and date—July 23d, 1876—the second engine—that under discussion in this article—has pumped for the week 4,-851,600 gallons of water, and consumed 6,400 pounds of coal.

∴ A performance which reduces to 75,806,000 maximum, or 50,535,000 minimum duty.

For the four weeks ending July 23d, the second engine is stated to have pumped 19,792,000 gallons, and consumed 25,495 lbs. of coal.

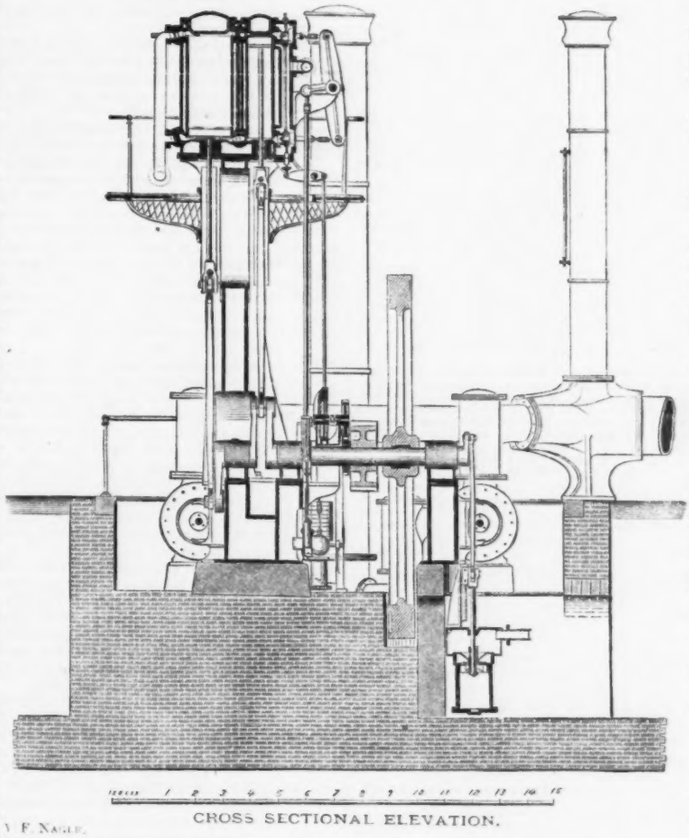
∴ A performance which reduces to 77,613,000 greatest, or 51,742,000 least, duty.

How much was pumped to waste through the relief valves was not stated, but possibly it was an equal proportion on the two engines; the difference of quantity of water pumped is accounted for by the increase of water supply to the district. On the four weeks' service the last engine appears to be about 6.11 times more efficient than the first. —*Journal Franklin Institute* for September.

PUMPING ENGINE

FOR THE

PROVIDENCE, R. I. WATER-WORKS.



CROSS SECTIONAL ELEVATION.

F. NAGLE.

Experiments with a Flitch Plate Girder.

[Taken from the Records of the Engineers' Club of St. Louis.]

The following experiments with a "flitch plate girder" may be of interest. They were made in 1871 during the construction of the building for the Polytechnic department of Washington University, by C. M Woodward, Professor of Applied Mechanics, and Mathematics, at that institution.

The girder in question was 15 inches high, 20 feet 8 inches long and 9 1-5 in. thick. One wooden girder being 4 in. and the other 5 inches thick, and the iron plate (which was rated ¼ in.) was 1-5 in. thick. The distance between the bearings was 20 ft. The weight was, in all cases applied in the centre. I first tested the wooden girders without the iron. They were bolted securely together. The deflections were noted for each 400 lb. till the load reached 6,507 lbs. The average deflection for each 400 lbs. was .0034 of a foot, the total deflection for 6,507 lbs. being .054 of a foot.

The girder always sprung back to its first position whenever the load was wholly removed. The iron plate was then firmly bolted in and the process was repeated. Deflections were carefully observed for the same load as before.

A comparison with the former results shows that the girder was much stiffer with the plate, thus:

	Without plate.	With plate.
Average deflection for each 400 lbs.	.0034 ft.	.0018 ft.
Total " " 6500 "	.054 ft.	.029 ft.

The *stiffness* of the girder was about ***doubled*** by the plate. This was shown also by the loads required to produce the same deflections in the two girders. Thus, it required 11,325 lbs. to produce the same deflection (.054 ft.) *with* the plate, that 6,500 lbs. did *without* it.

The load upon the compound girder was gradually increased with uniformly increasing deflections till the load was about 18,000 lbs. whan the girder took a permanant set which continued increasing till the load was 24,000 lbs. when owing to the yielding of the wooden sides of the girder upon the bearings, it became unmanageable and the loading ceased. The plate had cracked loudly several times and the top in the centre showed signs of buckling into the wood, but when removed from the girder, although the plate was permanently bent, it showed no fracture of any kind. The bolts were uninjured, but the holes near the centre had been enlarged.

Hence it was obvious that the wood had yielded to the bolts on their upper sides, and consequently the plate had deflected less than the wood, and so allowed the wood to do its share of the work in sustaining the load. Hence though differing greatly in their elasticity, the wood and iron worked well in combination. The increased strength of the girder, owing to the plate were plainly evinced by the fact that even after a considerable part of the load was removed, the wooden pieces alone, exhibiting as yet no fracture of any kind were quickly snapped in two by the remainder of the load.

The experiment showed most conclusively that a "flitch-plated" pine girder is: 1st, very much stiffened by the iron; and 2nd, that its ultimate strength is greatly increased.

IMPROVEMENT OF RIVERSIDE AVENUE.

Proposals for Estimates for Improving and Constructing Riverside Avenue, between 72d Street and 130th Street, in the City of New York.

Department of Public Parks, 36 Union Square, New York.

SEALED PROPOSALS for this work, indorsed with the title of the work, the name or names of the person or persons presenting the same, and the date of presentation, will be received at the office of the Department of Public Parks, until 9.30 o'clock a. m. on Wednesday, the 4th day of Oct. 1876, at which hour they will be publicly opened by the Head of the Department, and read, and the award of the contract will be made, as soon thereafter as practicable, to the lowest bidder with adequate security. The adequacy and sufficiency of the security offered to be approved by the Comptroller.

The person or persons to whom the contract may be awarded, will be required to attend at this office, with the sureties, and execute the contract within two days from the date of the service of a notice to that effect; and, in case of failure or neglect so to do, he or they will be considered as having abandoned it and as in default to the Corporation, and thereupon the work will be readvertised and relet, and so on until the contract be accepted and executed. The work to commence at such a time as may be designated by the Department of Public Parks.

N. B.- *The prices must be written in the bid, and also stated in figures, and all proposals will be considered as informal which contain bids for items not called for in the advertisement.*

The right is expressly reserved by the Department of Public Parks to reject any and all bids which it may deem prejudicial to the public interests. Permission will not be given for the withdrawal of any bid or proposal. No bid will be accepted from, or contract awarded to, any person who is a defaulter, as surety or otherwise, upon any obligation to the Corporation.

Bidders are required to state in their proposals, under oath, their names and places of residence; the names of all persons interested with them, and if no other person be so interested with them, they shall distinctly state the fact; also, that it is made without any connection with any other person making any bid or proposal for the above work; and that it is in all respects fair, and without collusion or fraud and, also, that no member of the Common Council, Head of a Department, Chief of a Bureau, Deputy thereof, or Clerk therein, or other officer of the Corporation, is directly interested therein, or in the work or supplies to which the same relates, or in any portion of the profits thereof.

Each proposal shall be accompanied by the consent, in writing, of two householders or freeholders of the City of New York, with their respective places of business or residence, to the effect that, if the contract be awarded to the person making the estimate, they will, on its being so awarded, become bound as his sureties for its faithful performance; and that if he shall omit or refuse to execute the same, they will pay to the Corporation any difference between the sum to which he would be entitled on its completion, and that which the Corporation may be obliged to pay to any higher bidder, to whom the contract may be awarded at any subsequent letting. The consent above mentioned shall be accompanied by the oath, in writing, of the person signing the same, that each is a householder or freeholder in the City of New York, and is worth the amount of the security required for the above work, over and above all his debts of every nature, and over and above his liabilities as bail, surety, or otherwise; that he has offered himself as surety in good faith, and with an intention to execute the bond required by section 27, art. 2, chap. VII. of the Revised Ordinances of 1866, if the contract shall be awarded to the person or persons for whom he consents to become surety.

Bidders will state in writing and also in figures, a price for each of the items mentioned in the Engineer's Estimate.

These prices are to cover the furnishing of all the necessary materials and labor; and the performance of the work set forth in the specification and form of agreement hereto annexed, and the completing of the entire work.

The Engineer's estimate of the work to be done, and by which the bids will be tested, is as follows:

(1). 225,000 Cubic yards excavation of earth.
(2). 125,000 " " " of rock.
(3). 380,000 " " embankment.
(4). 50,000 " " dry wall.
(5). 925 " " parapet wall laid in cement.
(6). 13,000 Lineal feet coping for parapet walls.
(7). 800 Cubic yards brick masonry.
(8). 1,500 " " concrete.
(9). 3,000 " " rubble masonry laid in cement.
(10). 2,000 Shoes for piles.
(11). 70,000 Lineal feet piles.
(12). 150,000 Feet, board measure, timber and plank, for foundations.
(13). 175,000 Pounds cast iron.
(14). 10,000 " wrought iron.
(15). 200,000 Feet, board measure, trestle work.
(16). 12,000 Lineal feet 12-inch pipe sewer.
(17). 4,000 " " 8-inch "
(18). 2,000 " " 6-inch "
(19). 90,000 Square yards pavement of wheelway of drive.
(20). 14,000 Square yards pavement of ride.
(21). 47,000 " " pavement of walks.
(22). 40,000 Square feet gutters.
(23). 200 Lineal feet straight granite curb.
(24). 800 " " granite curb angle stones.
(25). 17,000 " " blue-stone curb.
(26). 30,000 " " blue-stone edging.
(27). 500 Square feet blue-stone edging of special form.
(28). 25 Lineal feet circular corners of granite.
(29). 450 " " circular corners of blue stone.
(30). 55,000 Square feet flagging.
(31). 12,000 " " granite crosswalks.
(32) 500 Cubic feet granite steps.

These quantities are considered as approximate, and are not to be held as entitling the contractor to any claim for extra time in the completion of the work, or to any claim for damages, if the quantity of work between the points stated should prove to be greater or less than is here estimated, and the Department of Public Parks expressly reserves the right of increasing or diminishing the said quantities, as in its opinion may be necessary.

The attention of bidders is particularly directed to Section II. of the contract.

The amount of security required is Two Hundred and Fifty Thousand Dollars.

Blank forms for proposals, and further information, if required, can be obtained on application to the Secretary, at this office.

The form of Agreement, including the Specifications of the work, is annexed.

WILLIAM R. MARTIN, President of the Department of Public Parks.

Form of Agreement, to be Executed in Triplicate,

Under authority of Chapt. 447, Laws of 1876.

For improving the avenue known as Riverside Avenue, in the City of New York, as laid out under the second section of chapter eight hundred and fifty, of the laws of 1873, and shown upon a map thereof, filed under the provisions of said section, on the twenty-third day of February, 1875, by the construction of the roadways, curb and gutter and sidewalks which have been or may be adopted by the Department of Parks.

This Agreement, Made and concluded this day of in the year one thousand eight hundred and seventy-[redacted], by and between the Mayor, Aldermen, and Commonalty of the City of New York, of the first part, by the Department of Public Parks, and

of said city, contractor of the second part.

(A). **Witnesseth,** That the said party of the second part has agreed, and by these presents doth agree, with the said parties of the first part, for the considerations hereinafter mentioned and contained, and under the penalty expressed in a bond bearing even date with these presents, and hereunto annexed, to furnish, at his own proper cost and expense, all the necessary materials and labor for improving Riverside Avenue, between 72d and 130th Streets, in the City of New York, and to improve and construct the same, in the manner and under the conditions hereinafter specified; and has further agreed that the said Department of Public Parks shall be, and it is hereby authorized, to appoint such and so many Engineers, assistants, inspectors and other persons as it may deem necessary to properly inspect the materials to be furnished and the work done under this agreement, and to see that the same correspond with the specifications hereinafter set forth.

(B). To prevent disputes and litigations, it is further agreed, by and between the parties to this contract, that the Engineer, appointed by the said Department to superintend said work, shall in all cases determine the amount or the quantity of the several kinds of work which are to be paid for under this contract; and he shall determine all questions in relation to lines, levels and dimensions of work.

(C). And it is further agreed by the parties to this agreement, that whenever the Engineer aforesaid shall be unable to act, in consequence of absence or other cause, then the principal assistant under him, when required by the Department of Public Parks, shall perform all the duties and is vested with all the power herein given the said Engineer.

SPECIFICATIONS:

General description. 1. That portion of Riverside Avenue included in this agreement, is to be graded, the roadways and side-walks to be constructed, the curbs set and gutters laid, and such retaining walls, basins, pipes and other constructions necessary to such improvement, and described hereinafter, are to be provided and built, and all other work done, and labor and materials furnished, and put in place, as are hereinafter more particularly described, all in accordance with the plans, profiles and drawings, prepared by the Department of Public Parks.

Work and materials must agree with specification. 2. All materials furnished, and all the work done, which, in the opinion of the Department of Public Parks, shall not be in accordance with these specifications, shall be immediately removed, and other materials furnished, and work done, that will, in the opinion of the said Department, be in accordance therewith.

Clearing and grubbing. 3. From such portions of the grounds, as may be directed, all trees, saplings, bushes, stumps, and roots, (except such as said Department directs to be saved) shall be cut and thoroughly grubbed up, and together with logs, brush, fence-material and wood of every description, be removed from the Avenue, and disposed of by said contractor. No payment will be allowed for this work of clearing and grubbing, it being considered as included in the prices to be paid for excavation and filling.

Excavation and disposition of top soil. 4. At such portions of the grounds, and for such widths and depth as may be directed, the soil shall be excavated, and either spread over the ground at such places, and in such depth and to such lines and slopes as may be directed, or placed in piles of such dimensions and at such localities as may be directed, and to give not exceeding twelve hundred feet haul for said material. These piles to be of regular shape with well made faces. Said soil to be and remain the property of the City of New York. The price for excavation of earth per cubic yard to be in full for the excavation, removal, spreading or piling said soil. If so directed during the progress of the work, such soil so piled shall be again removed and spread over the slopes or other portions of the work, at such places and in such depth as may be directed, but to give not exceeding twelve hundred feet haul. For this second movement of soil the price for excavation of earth will be paid, and will be in full for the re-excavation, removal, placing, and spreading said soil.

Excavation of earth. 5. At such portions of the grounds, and to such widths, depths, and lines as shall be directed, the material not included in the previous specifications is to be excavated so as to conform to the required grades, slopes, trenches, pits or other prescribed lines. All material excavated under this specification is to be classed and paid for as earth excavation, except solid rock.

Boulders and detached rock will be classed as earth excavation, except where such boulders or rock measure one-half cubic yard or more each.

The material excavated shall be removed and deposited, as shall in each case be directed, at the points at which it may be required for embankment or other purposes, and in accordance with the provisions of these specifications.

The price for excavation of earth will include the excavation, shaping slopes, removal and final deposit in accordance with these specifications of all the material herein described.

Excavation of rock. 6. Where rock occurs it shall be excavated to conform to the required grades, slopes, trenches, pits, or other prescribed lines.

The excavation of solid rock, and of boulders or detached rock measuring one-half cubic yard or more each, will be classed as excavation of rock.

The excavated rock shall be removed and deposited, as shall in each case be directed, at the points at which it shall be required for its use as herein specified. It shall be used for embankment, for retaining wall, for road constructions or for such other purposes as may be directed.

The price for excavation of rock will include the excavation, removal, and final disposition of the material in accordance with these specifications.

Embankment. 7. The embankments are to be made of the material and in accordance with the lines, slopes, grades and dimensions directed.

No rock filling will be allowed within three feet of the finished grades, nor in such parts of the embankments as will interfere with trenches or pits to be afterwards excavated, or with provisions for roots of trees.

In embankments made of stone chiefly so much earth shall be deposited with the stone as shall be sufficient to fill the interstices thereof.

Where so directed, the filling behind the walls shall be made in layers, with such inclination as shall be prescribed.

Measurement of embankment. The total amount of embankment made, from whatever sources the material may be procured, shall be measured and paid for at the price bid for embankment. But for each cubic yard of earth excavated under this contract, as measured in excavation, the said Contractor shall allow the said parties of the first part, the price bid and paid per cubic yard for embankment; and for each cubic yard of rock excavated under this contract, as measured in excavation, the said Contractor shall allow the said parties of the first part, the price bid and paid for one and a half cubic yards of embankment.

The sum of said allowances for earth and rock excavated, at the price bid for embankment, shall be deducted from the estimates made in accordance with this agreement. All embankment furnished, to be good, wholesome earth, wherever earth embankment is directed.

Retaining wall. 8. The retaining wall is to be dry masonry, up to the height show no nplan,

Foundation wall. (*a*). The foundation will be laid at the depth directed in each case, and will consist of large, quarried stone, squared, jointed and bedded; and one fifth of the same shall extend through the wall or at least four feet back from face. The stones are to be well adjusted to give a uniform bearing, and carried up to a line, as shown on plan, above which line the wall will be more accurately faced and battered.

Main wall (*b*). The wall above this line must be well and truly laid by line and template. It is to be laid dry, in irregular courses, except that in the face of the wall, at or about every six feet in its height, the face-stones shall be brought to a level course for lengths, as shall be directed, thus showing on the face of the wall horizontal lines. These horizontal lines are not to be continuous, but are to be of the lengths, and to occur at the places designated by the Engineer, so as to secure a horizontal line at or about each portion of six feet in height of wall.

The stones in the wall are to contain generally from six to twenty cubic feet each, so disposed as to make firm and compact work. No stone in the wall to contain less than two cubic feet, except those permitted to be used for filling the interstices between the larger pieces in the heart and back of the wall. At least one fifth of the face shall be composed of headers, extending through or not less than four feet into the wall, and headers shall also be laid from the back of the wall alternately with those in the face, and with the same dimensions.

The face stones will be left with quarry faces, unless projections exceed three inches, in which case they will be roughly brought to that limit. Joints on the face shall be laid closely, and the stones used in face must be sufficiently dressed to insure this result.

The face of the wall must be on the batter shown on plan. The whole wall must be of the full thickness shown on plan. The dimensions shown on plan will be used in determining the amount of wall.

So much of the upper portion of this wall as shall be directed shall be laid in cement, in accordance with the Specifications for stone masonry. For such portions of the wall, so laid in cement, the price bid for rubble masonry laid in cement will be paid.

The top of the wall must be brought to lines true and parallel with the grades given, and the top must consist of through stones, running from front to rear, and brought to an even bed to receive the parapet-wall above.

Parapet wall. (*c*). The parapet-wall will consist of stone with rock faces, both front and back. It may be either one or two courses in its height. If of one course, the stone must be of the full dimension of the parapet in each direction, no centre vertical joint being allowed. If of two courses in height, one of the courses must be of the full width of the wall, and the other may have a centre vertical joint, this joint not to exceed one inch in thickness; neither of the courses to be less than seven inches in height.

This parapet-wall must conform to the lines of plan, both front and rear; must have rock face, both front and rear, with no depressions or elevations exceeding two inches; must be laid in full cement mortar, and with well pointed joints. The joints not to exceed one quarter of one inch.

The top surface must be brought to a perfectly true and even bed to the lines and grades given, and made ready to receive the coping, as hereinafter specified.

Quality of stone. (*d*). All the stone used in the wall, whether foundation-wall, main dry-wall or parapet, is to be sound, durable, and of good quality, clean and free from check and defect. It may be of gneiss or granite, and may be from the excavations on the work, as far as suitable stone can be thence supplied.

Stone filled in rear (*e*). Immediately behind the wall loose stone shall be filled in if so directed to a width and in a manner to be directed by the Engineer. This stone filling will be measured, estimated, and paid for only as a portion of the embankment.

Coping for parapet wall. 9. The coping stones for parapet-wall are to be of granite, of a sound, durable quality, and to be approved by the said Department as to color and quality. They are to be of the dimensions shown on plan. The top is to be coarse axed. Both sides to be rock-faced, with no depression or elevation beyond the working lines to exceed one inch. The inside face is to have a chisel draft of not less than one half of one inch along the top and bottom of each stone. The bottom to be dressed so as to lay one quarter-inch joints. The end joints to be dressed to the full width and depth, so as to form joints not exceeding one quarter of one inch.

The stones are to be not less than three and one half feet in length. All the stones must be perfectly true to lines, out of wind and of full dimensions in all parts.

The coping is to be laid in full beds and end-joints of mortar, not to exceed one quarter of one inch.

All mortar-joints are to be neatly pointed and rubbed while fresh.

Foundation trenches for wall. 10. The foundation trenches will be excavated to the depths and dimensions directed. The materials from trenches will be moved and deposited where directed, and the amount excavated will be measured and paid for as excavation of earth or rock, as the case may be. Where rock occurs, it shall be excavated to such bed for foundation of wall as shall be directed.

Piling and timber foundations. 11. Should piling or timber foundations be required, they will be put in as directed, and paid for as hereinafter specified.

Concrete. 12. Should concrete be required, it shall be put in and paid for as hereinafter specified.

Openings in wall. 13. Such openings through the wall as may be directed, shall be made and properly and strongly built about with stones, selected for the purpose, and in a manner approved by the Engineer. The cubical contents of such openings shall be estimated and paid for as part of the wall built.

Pipes through wall. 14. Where directed, pipes of iron, stone-ware or other material shall be laid in or through the wall at such points, and with such inclinations, projections, and protection as shall be described. The payments provided hereinafter in reference to these pipes will be in full for all work, either in wall or otherwhere connected with them.

Dry stone culverts. 15. Where required, under embankments, or at any other points that may be directed, dry rubble-stone culverts are to be built. These culverts shall be of the form and size to be shown by plans. The bottoms are to be paved for the entire width of the opening, and side walls with stones nine inches in depth, laid compactly together, with an even surface. Payments for these culverts will be made per cubic yard at the price bid for dry wall.

If the ground for foundation of culvert is not firm, it shall be dug out to such depth as directed, and filled compactly with stone, or such other provision therefor shall be made as the Engineer shall direct.

No allowance. No allowance will be made for pumping, bailing or draining of water in connection with this or any part of the work.

General drainage. 16. The general drainage will be provided for by inlet-basins, by vitrified stone-ware pipe, and by iron delivery pipes, and by such other means as are herein specified, or are shown on the plans.

Trenches. 17. The ground shall be excavated in open trenches to the necessary width and depth.

Width. The trenches shall be one foot wider on each side than the sewers intended to be laid in them, at the point of their greatest external diameter, and the bottom of the trenches shall be excavated to the exact form and size of the lower half of the Sewers, where required by the said Department.

No tunneling. No tunnelling will be allowed, except by consent of the said Department.

Shoring. The sides of the excavation shall be supported by suitable planking and shoring wherever necessary, but no allowance will be made therefor, and in all cases the same to be drawn as the work progresses.

Safety of trees. If at any points the safety of trees should require it, such precaution shall be taken as shall be directed by the Department of Public Parks.

Foundations to be made good. All irregularities in the bottom of the trenches shall be filled up to the required level, with gravel or clean sand, firmly rammed in; and where the ground does not afford a sufficiently solid foundation, the Contractor shall excavate the trench to such increased depth as the Engineer may decide to be necessary, and shall then bring it up to the required level and form with such material and in such manner as the Engineer shall determine.

Length of trench to be opened 18. No more than one hundred feet of trench shall be opened at any one time in advance of the complete building of the Sewers, unless by order of the Engineer, and for the distance specified by him.

On the completion of each section of one hundred feet of Sewers, the regrading, over the same, shall be completed, and all surplus earth, sand, or rubbish on that section shall be removed by the Contractor.

Pumping and bailing. 19. The Contractor shall, at his own expense, pump out, or otherwise remove any water which may be found, or shall accumulate in the trench, and shall form all dams or other works necessary for keeping the excavation clear of water during the progress of the work.

Quicksand. When running-sand, quicksand, or other bad or treacherous ground is encountered, the work shall be carried on with the utmost vigor, and shall be proceeded with day and night, should the said Department so require.

Drains, &c interrupted. 20. The Contractor shall provide for the flow of sewers, drains, or water-courses interrupted during the progress of the work, and shall restore and make good all connections, and shall immediately cart away and remove all offensive matter, with such precautions as may be directed by the Engineer.

Form of prism in rock excavation. 21. When rock is to be excavated, it shall be fully taken out thirty feet in advance of the laying of the pipe or sewers, and six inches below the grade of the outer bottom of the pipe or sewers, and the trench then filled up to the level of that grade with clean, sharp sand, and thoroughly rammed and made solid. The trench shall be one foot wider on each side of the pipe or sewer intended to be laid in it, at the point of its greatest external diameter, and from this point to the bottom of the trench the sides shall be vertical; and also from the same point the sides of the trench shall be sloped upward in the proportion of three inches horizontal to one foot vertical, and so continued until the trench has a width of twelve feet; thence to the surface the sides are to be carried up vertically, and at a width of twelve feet. No rock outside of the lines above described will be estimated or allowed.

Blast to be protected. In all cases of rock blasting, the blast to be carefully covered with heavy timber, according to the ordinances relative to rock blasting.

Rock to be stripped for measurement. Wherever rock is encountered in excvating the trench, it shall be stripped of earth in sections of not less than fifty feet, and the Engineer in charge duly notified, in order that he may measure or cross-section the same; and all the rock excavated or blasted out before such measurement is made will not be estimated or allowed.

Soft or disintegrated rock &c., not to be allowed. No soft or disintegrated rock which may be removed with a pick, and no boulders or loose rock, in rock fillings or elsewhere, and no rock whatsoever outside the lines of the trench, which may have been previously loosened, and which, by reason of such loosening, may fall into the trench, will be measured or allowed.

Payment for excavation of trenches. 22. The amount of material excavated, whether rock or earth, in opening trenches for drainage, as herein specified, shall be measured, estimated, and paid for at the price bid for excavation of rock or excavation of earth, as the case may be, which price shall include payment for all work connected with opening trenches, as herein specified.

Refilling. 23. After the Pipe or Sewer, with its required foundation, is laid or built, the work shall be backed in, and carefully packed and rammed by trusty persons, under and around it, with proper material and with proper tools. In refilling, the earth or sand shall be faithfully rammed as the work progresses, and in no case shall the number of men backfilling be more than twice the number of those ramming, nor shall the layers in any case exceed nine inches in thickness.

Kind of earth to be used. The refilling in all cases shall be of good loam, sand, or gravel, free from stones of above four inches in diameter, and in kind and proportion not to exceed one part of stone to three parts of earth. For a height of at least one and a half feet above the top of all Pipes or Sewers the material shall be entirely free from stones.

Free from stones.

Deficiency of material. Should there be a deficiency of proper material for refilling, the Contractor will be required to furnish the same at his own cost and in all cases the trench must be refilled to the same height as previously existed, unless the said Department shall direct otherwise.

The earth must be carefully laid in, so as not to disturb the pipes, and tamped and solidly rammed down under and around them with proper tools made for this purpose. The trench shall then be filled by layers, as above described, and the first layers, to a point at least nine inches above the top of the pipe, shall be carefully thrown in with shovels, and not from barrows or carts. In all cases of rock excavation, clean sharp sand must be provided, and refilled, in the manner above described, for a height of fifteen inches above the top of the pipe.

Payment for refilling is included in price bid for pipe. 24. The cost of refilling trenches for Pipes or sewers will be included in the price paid per lineal foot for furnishing and laying pipe. This refilling will therefore not be estimated or otherwise paid for.

Pipe sewers. 52. Where required, vitrified salt glazed stoneware Sewer and Drain Pipes shall be furnished and laid down, of the sizes and in the manner shown on the plan of the work, and herein specified.

How designated. (*a*). The pipes shall be designated by their interior diameters. Each pipe shall be a true cylinder, and shall have in every part an internal area equal to the full area due to its diameter.

Concentric. (*b*). The inner and outer surface of each pipe shall be concentric. All straight pipes must be straight in the direction of the axis of the cylinder.

Thickness (*c*). All pipes of a diameter under twelve inches shall in no part be less than six-eighths of an inch in thickness; those of fifteen inches, and not under twelve, shall in the same way be not less than one inch; and those of eighteen inches and not under fifteen, not less than one and two-eighth inches.

Made of best materials and glazed. (*d*). All pipes of whatever kind shall be made of the best material, thoroughly and perfectly burned, without warps, cracks, or imperfections, and shall be well and smoothly salt-glazed, in the best manner, over their entire inner and outer surfaces; and they shall be of equal quality in every respect to the samples exhibited at the said Department, and subject to all tests ordered by the Engineer at any time previous to their being used.

Lengths. (*e*). Each straight pipe, having no branch or connection, shall in no case be less than two feet in length.

(*f*). Each pipe, having an opening moulded into it, for house connection, or branch of any size or kind, shall not be less than two nor more than three feet in length, unless specially ordered.

Pipe to be fitted with collar. (*g*). Each pipe, of whatsoever kind, must be fitted with a sleeve or collar of the same character, cylindricity, and thickness, and not less than five inches in width, without extra charge therefor.

Size of collars. (*h*). Each collar must have an internal diameter of not less than one-half nor more than one and one-half inches greater than the external diameter of the pipe to which it is to be fitted.

Curved pipe. (*i*). When required, curved pipe shall be furnished and laid, curved to such a radius with the axis of the pipe as may be shown on the plan of the work, and no curved pipe shall exceed three feet in length.

Branch pipe. (*j*). Branch pipes and house connection drains, wherever designated, shall be furnished and laid of the size and form, and at the points shown on the plan of the work, and closed with a bulkhead of brick not less than eight inches in thickness, when not immediately used, or an approved stone or stoneware cover, free of charge.

Bends, &c. (*k*). Bends, siphons, and special pipe shall, if required, be furnished and laid of the sizes and forms shown on the plan of the work.

Hub and spigot pipe. (*l*). In case the Department of Public Parks shall elect to use hub and spigot pipe, they shall be furnished in all cases similar and equal in size, quality, and kind to those above described. The hub shall have a depth of at least three inches from its face to the shoulder of the pipe on which it is moulded, and shall have an interior diameter not less than one nor more than two inches greater than the exterior diameter of the pipe which is to be fitted into it.

(*To be Continued.*)

Water Works, Ancient and Modern.*

BY E. H. D'AVIGDOR.

(*Continued from page* 320.)

In the year 1782 Perier erected a steam pump, which raised the river water 110 ft., and distributed it to the Quartier St. Honore; but the choice of the station was very bad, being immediately below the city and in close proximity to a number of outfall sewers. With this pumping station closes the series of works executed for the water supply of Paris, before the great development of industry and science, and the great impetus taken by large cities which characterise the commencement of the nineteenth century.

I have attempted, as far as lies in my power, to draw a hasty sketch of what was done for the water supply of towns in ancient times and during the middle ages. As it was impossible to mention *all* the constructions erected for the purpose of water supply in different countries, much less to describe them, without far exceeding the limits of a course of lectures, I chose the two most interesting towns, which had the greatest influence on the development of our subject, out of the mass of available materials, viz., Ancient Rome, whose history, up to the fifth century of our era, is almost equivalent to that of the civilized world; then Paris, in which latter town I attempted to trace the gradual progress from the dirty obscurity of remote ages to the approximate physical, if not moral cleanliness of modern times. I am not myself in a position to judge how far I have succeeded in giving a clear although condensed view of this subject; but, at any rate, I think it as well to summarise briefly the historical conclusions to which we have come, so as to make these results perfectly comprehensible.

We find, during the Roman periods, constant endeavors to obtain fresh and perfectly pure spring water in large quantities; the erection of many magnificent and expensive aquedects for the supply of such water; a system of private supply, which was certainly faulty enough, but very extensive and almost gratuitous; an extravagantly liberal supply to wells, fountains, gratuitous public baths, and other establishments; finally, continued neglect of necessary repairs in the aqueducts, and, therefore, an immense waste of water.

During the middle ages we remark, first of all, that the great edifices, which the Romans had constructed in Italy and in many parts of Europe, were allowed to fall into complete decay; that there existed no recognition of the value of water at all, and no trace of any endeavor to obtain any quantity of wholesome water; the notion of supply was limited to fetching the water required out of the nearest stream available; later, when the town extended and dreadful sufferings had been caused by droughts in hot summers, some small works to bring springs into different towns were indeed introduced—as at Paris, Lyons, and Vienna—none of which, however, are worth mentioning in comparison to the Roman works. Then came the sinking of a number of public and private wells and the creating of a few fountains; but still, up to the end of the last century, no trace of any attempt at a general supply of private houses, but only a number of abuses by the concessions given to particular corporations and individuals for the purpose of tapping the mains.

With these conclusions in our minds we now come to modern times, when water is once more appreciated at its true value. But we have still long to wait before we see engineers and doctors find out that there are many different sorts of water. At the commencement of this century water was water—as long as it was drinkable and did not absolutely stink, it was considered good enough, and many years passed before even engineers and chemists came to the conclusion that the preservation of health in the human body depends to a great extent upon a sufficient supply of pure water. Indeed, I must confess that the ideas on this subject are hardly quite clear yet, and that many supporters of river-water supply consider the pollution of water, up to a certain extent, to be permissible and innocuous. This is a very ticklish question, which has given rise to innumerable discussions and polemical pamphlets. Really pure water—that is, water without any foreign admixture whatever—can only be supplied in the laboratory by means of distillation; and even rain water, which is theoretically pure, is practically always more or less contaminated by contact with the air through which it falls. Thus, rain water collected in London is so much polluted by carbon and gas as to be worse than that of contaminated wells; while the contents of the cisterns constructed in India for the storage of water falling during the rainy season are frequently most excellent in quality and almost pure. Fortunately, *absolute* purity is not required, and the quarrel turns only on the point how much, and what description of pollution may be admitted into water without making it unwholesome? It is at any rate certain, that water containing ammonia, or polluted by decaying organic and particularly animal matter, is extremely injurious to the human body; and that, in many cases, diseases of the intestines and pernicious fevers can be traced to the use of it. Many chemists and physicians maintain that the germs of typhus and cholera (particularly those arising from the excreta of sick persons) can be conveyed in water, and are capable of producing these diseases after a long period, and notwithstanding a prolonged flow under or above ground. And this opinion has gathered force by recent experiences in England, notwithstanding the opposite view of so eminent a man as Professor Pettenkofer, of Munich. It is true that these germs have hitherto escaped chemical analysis, and the view that they are directly poisonous cannot therefore be declared as absolutely proven. But it is absolutely indisputable that water contaminated by certain organic matter is extremely injurious, and that certain inorganic matters (*e. g.*, sulphur) are also very unwholesome. As it therefore appears certain that pure water is wholesome, while, on the other hand, polluted water is unwholesome and *may* be poisonous, common sense should cause us to look for the purest possible water whenever a supply is required for any given town; and it must not be forgotten that this should be such as not to be exposed to any future pollution. The cost should be quite a secondary consideration. A whole town may be poisoned by the supply of water being exposed to contamination, and engineers may actually, though unwittingly, now commit the same crime on a large scale which was often falsely charged to the Jews in the middle ages, viz., that of poisoning the wells, and this poisoning will be all the more serious in its consequences as the supply to private houses is more general and more perfect. Cases have recently occurred which prove this fear not to be entirely groundless, for there is no doubt that some recent violent explosions of typhoid fever were due to the pollution of the water supply only, and are in fact nothing but cases of poisoning. It seems clear, therefore, that the first and principal care of the water work's engineer should be to supply the purest possible water; and we must sincerely regret that the cost should be considered at all, when it is a question between water of different degrees of purity.

I have discussed this question at greater length than I ought perhaps to have done with regard to the space allotted me, because I consider it so important that in all future works for the supply of water to towns, the quality of the water should first of all be considered without regard to its distance, its altitude, or the cost of bringing it, while unfortunately even in England its importance is so frequently neglected. And you will be the more inclined to forgive my standing up for this cause, that you can all of you go away from this institution with the consciousness that the Vienna aqueduct supplies water of the purest quality, perfectly wholesome, and singularly cool, and that no pollution of it need be feared at any future time. In respect to the quality of water these springs can compete successfully with all the great water works executed in modern times, and carry away the palm even from ancient Rome itself.

It is now high time to pass on to actual works executed, and I will, with your permission, abandon my historical method for a moment, in order to classify modern water works, according to their sources of supply. We can divide them into three classes.

First, spring water supply, of which I have already said so much. These, again, may be subdivided into two; viz., (*a*) when the springs are received directly into a chamber whence they supply the aqueduct or main; or (*b*) when greater or less lengths of catch-water drains or pipes of porous material are laid in the ground, which then unite in a chamber and thus create an artificial spring. Although this latter system has been extensively advocated by distinguished engineers, and has been successfully applied to many towns in Germany, it presents the great disadvantage, which even an outsider will at once understand, that the level of the underlying water may be, and often is, permantly lowered by its adoption, so that when once the ground has been, so to say, thoroughly drained, the supply from the water-bearing strata generally falls far short of the result of the previous gaugings. Thus the Dantzic Water Works at first supplied 450,000 cubic feet a day regularly; they now hardly average 300,000, and occasionally the supply falls to 240,000.

A natural apring, or group of springs, is therefore always to be preferred, if available, as by catching this up no alteration is made in the hydrostatic condition of the surrounding country. In this respect Vienna has again a great advantage. For while in most towns it is a matter of difficulty to find any springs at all, delivering a sufficient quantity of water with any regularity, the supply in the more distant environs of Vienna is so considerable, that it was only a question which of many springs should be tapped. The difficulty above alluded to, however, has led to the adoption of the—

Second great method of supply, viz., that from rivers. The water may be taken either directly from the stream or from wells sunk in its banks. This system is the more plausible, as the supply can generally be increased at will, and the river often furnishes the motive power to raise the water. Of course the first cost is far below that of a spring water supply. No long aqueduct or main is required, and the choice of a station is much less circumscribed than in the case of springs. In modern times the water is filtered; it is generally soft, and has therefore considerable advantage over most spring water for cooking, household, and manufacturing purposes. On the other hand it is seldom free from organic and other impurities in solution, which of course cannot be removed by filtering. Its temperature changes with the seasons, and in the case of direct pumping the motive power may frequently be interrupted by ice; nay, the water supply itself may be stopped altogether in severe climates. Water power has therefore been abandoned in favor of steam pumping, which is now universally adopted. But it must not be forgotten that, if the first cost is considerably less than in the case of spring water supply, that of maintenance is much greater. Not only do the pumping engines entail a constant expenditure for fuel and attendance, but they must also be renewed after a series of years, and reserve power must always be available in case of accident. Gravity is cheaper than steam. But a still more serious objection is the *quality* of the water. Towns have lately extended to such an degree within a short space of years, that pumping stations which were formerly quite remote from human habitation, far above the mouth of the first sewer, and exposed to no pollution, are now surrounded by houses, and can supply nothing but seriously contaminated water. In such cases the station becomes useless and dangerous, and must be removed elsewhere to the great cost and inconveience of the ratepayers.

Water out of *navigable* streams is invariably exposed to constant pollution of the most subtle and dangerous description. The water of the Vistula, for instance, is supposed to have conveyed the cholera from Poland to Dantzic. Bargees and long-shore men do not represent the cleanest part of the population: I should like therefore, to see water supply from navigable rivers completely and absolutely condemned.

In the case of spring water, the only precaution necessary is to secure the ground in its immediate vicinity—then no pollution need be feared. This operation is generally easy, as property in hilly countries is less valuable than on the banks of rivers, nor need the area purchased be so large. In the one case, no precautions and no purchase of property, however extensive, can secure the water against pollution; in the other, this security can be obtained at a comparatively moderate cost. I may here mention the Dresden Water Works, which have just been completed by the well-known engineer, Mr. Salbach, as an example of the best that can be done with a river water supply.

(*To be continued.*)

* A course of papers delivered at the Austrian Institution of Engineers and Architects, December, 1875, and January, 1876.

The flow of water in the breast of the Sutro tunnel (Nevada), has inceased to 250 miner's inches.

THE PANAMA PROBLEM.

A statement is going the rounds of the papers that Rear Admiral Cochrane has written to the London *Standard* suggesting that it would be to the interests of England to survey a route for a canal up the Bayamo river which empties into the Pacific about twenty miles to the eastward of Panama, to a village named Jesus Maria, and from there to the harbor of San Blas, on the Atlantic. The course he recommends for survey is the shortest across the Isthmus, viz., about 29 miles. He states that he ascended the Bayamo river on May last, to Jesus Maria, in 3½ hours steaming, and carried a depth of several fathoms, except over some sand bars, and that the tidal rise of the Pacific extends several miles beyond. The point which he attains is within 19 miles, in a direct line, of the port of San Blas.

Now if this were all true, and it is largely true, it would certainly be very gratifying; but taking the facts as they exist, in comparison with the misleading paragraph which we have abstracted, and the currency which papers of a *quasi* scientific character have given to it, it furnishes a most excellent text for an editorial on the shortcomings of a certain class of men of omniverous capacities who occupy tripods in the sanctum and with scissors and paste prepare original items of foreign and domestic intelligence, or paraphrase said items into the form of "editorial notes" with enough of admixture of editorial comment to warp the sense and "owlify" its appearance to the uninitated reader.

On referring to ENGINEERING NEWS of August 26th, we find the following paragraph:—"The San Blas route, although only 27 miles from ship navigation, would require a ship tunnel 10 miles long, for a canal at tide level, and one 7 miles long for a summit [level] 372 feet high. It is utterly impracticable as compared with other routes."

Our foreign friends seem quite unaware that this route along with several others was quite fully surveyed by Commander Selfridge of the U. S. Navy, the results of his survey being detailed at considerable length in a special report, and accompanied by the most authentic map of the Isthmus yet published. The San Blas route had also been previously investigated, though not so fully, at the expense of a citizen of New York city. These facts seem also to have escaped many of our friends in this country, judging by the currency given to misleading reports in regard to operations in contemplation on the Isthmus.

It may be gathered from the report alluded to that the tide was a considerable distance above Jesus Maria, and further that the Bayamo forks above this point, the larger and main branch coming from the east or southeast along a line nearly parallel to the mountain chains which skirt the Atlantic coast. The other fork, and the one followed in the surveys, breaks through the first range or foot-hills but does not penetrate far enough toward a similar valley opening out into the Gulf of San Blas to give a divide of less than a thousand feet hight, though no doubt it gives the lowest divide in this immediate portion of the Isthmus. While the report and the results of private survey show this to be the shortest route across the Isthmus, it is certainly one of the most impracticable.

However, if the English expedition should be organized, as recommended by Admiral Cochrane, it cannot but add additional light in regard to the physical geography of the Isthmus, which is confessedly scanty and altogether too inadequate to definitely fix the great interoceanic canal. Probably the action of the commission in deciding on last November in favor of the Nicaraguan route was well advised in the light of what is known, but we consider their action premature and one which we think will be found a great mistake in the light of subsequent information. There are so many elements in the problem that we can afford to make haste slowly.

Apropos of this canal question we notice a communication in the *Polytechnic Review* written by Leon Drouillet, Secretary of the French Section of the International Committee to study the question of cutting a canal through the American Isthmus, who is now in this country for the purpose of securing the co-operation of the American Geographical Society of New York, in the appointment of the American Section of the Committee. It appears that in August, 1875, the International Geographical Congress, held at Paris, took up the question of a canal across the Isthmus, and after an inconclusive discussion, passed the following resolution: "That the governments of the different countries interested in this great work should give every possible encouragement to a thorough study of it, and that their attention should be particularly devoted to those routes which offer the greatest advantages to navigation, from their accessibility and from the few obstacles in passing through them." At the same time Leon Drouillet presented a paper in which was summed up all the results yet reached in the investigation of the Isthmus, and in compliance with the appeal therein, the Commission of Commercial Geography, and the Geographical Society of Paris, took the matter actively in hand and appointed on March 24th, 1876, the French Section of the International Committee to study, etc. Among the members of this section are the President, M. Ferdinand de Lesseps, manager of Suez Canal Co.; the Vice Presidents, M. de la Ronciere de Noury, Senator, Vice Admiral and President of the Paris Geographical Society; and M. Meurand, Honorary President of the Paris Geographical Society, and the Secretary, Mr. Leon Drouillet, an engineer and member of the Paris Geographical Society. The French section has received subsidies from the government, and has entered into relations with all the geographical societies of the world, begging them to cooperate, and to have sections formed in their respective countries similar to the one in France. Most of the societies of Europe have already complied and will be represented at the first meeting in November. It is understood that the American society will appoint their section this month. It is hoped that this organization will have the hearty support of all Americans, who are really the most interested, and further that the organization will not prove too unwieldy for efficient work. As a final outcome this Isthmus question should be investigated, beyond a doubt, by the sending of additional parties to the Isthmus, if necessary, so that when the construction of the canal is finally assumed there shall be no lingering belief in a better route. Americans should not deceive themselves in regard to its being an international question, for in all history there has been no two schemes of so common an interest and of such consequence to the world at large as the Suez canal and the Panama canal. The first is completed; and for all time there will be nothing of so much importance to commerce as the Panama canal. Let the question be most thoroughly investigated while the need for its construction is comparatively in its infancy.

THE NAVY OF THE FUTURE.

In Europe, ever since the introduction of iron-clad war vessels, there has been a constant strife between the armor and the armor-piercing gun. No sooner was a vessel constructed and loaded down with armor-plates so thick that it was expected that no shot could pierce it, than a gun was straightway produced that could penetrate its walls as though they were paste-board. Then more heavily armored vessels and heavier guns were produced until "fighting machines" assumed huge proportions in order to carry her machinery and heavy iron skin, until her size and cost was a practicable bar to further developments in this direction.

The outcome is a ship of great tonnage, of great cost, but of small carrying power, and hence not able to stay long from port or her coal supply. The heavy guns gained the day, and at the present time they have been constructed and can be constructed to throw a projectile through the thickest armor that can be made to float. Possibly to this remark may be excepted the Russion circular iron-clads of Admirable Popoff, which, however, are available chiefly as great floating batteries or forts, easily manoeuvered and capable of moderate speed, and which, owing to their great displacement relative to their surface, can be made to carry almost any thickness of armor. But while the guns were quietly gaining the day in this scientific fight, a new element in the shape of a torpedo boat was introduced into the problem—small and spry boats, very swift, lightly armored, to spring on their antagonist in a moment ere they could overcome their inertia as it were. Then again, the Lay Torpedo which can be sent out for a mile or more, swift as a courier, propelled by carbonic acid and directed through the water by means of an electric cable, feeling its way and striking the fatal blow as accurately as if possessed of a mind. To guard against these new dangers it was thought to hang a wire netting about a ship at such a distance as to prevent the approach of the devilish "Pucks." Imagine the proud war vessel of Britain in crinoline, th'o "He who fights and runs away will live to fight another day." The final outcome is the adoption of a very swift, well-armed vessel, able to run away from the monsters and the devilish devices called torpedoes, and in the future we shall learn that he is the best fighter who can sail out of harm's way the most expeditiously. We learn from the London *News* that half a dozen steel corvettes, to be built on the Clyde, and to be ready for service within two years, are to be added to the British Navy, chiefly for cruising purposes in the foreign colonial possessions. They are to be of 2300 tons, with powerful engines to enable them to make 20 miles per hour without difficulty. Their armament will consist of fourteen guns of various calibres. The machinery will be protected by heavy armor. The *News* says: "Such vessels as these will be able to perform the specially important service of pursuing and destroying the swift torpedo boats," and again, "their great speed will always enable them to show their sterns and prevent hostile craft from approaching." War ships and appliances are not now built and maintained for the purposes of war, but to prevent war. That nation which keeps ahead in scientific methods of destruction is quite the last to be attacked and the surest to have its own way. Nations are much like a policeman who rushed around the corner during a great row and arrested a small news-boy.

MANCHESTER A SEAPORT.

The scheme of making Manchester, England, a seaport is being revived. It is estimated that the works required would cost about £3,500,000. It is proposed to improve the tidal basin of the Mersey, above Liverpool, as far as Warrington Bridge to which spring tides extend, by properly constructed low water dykes and jetties or groins which shall so direct the ebb tide through the shifting sands of this basin as to scour out and maintain a deep low water channel. It is expected that this operation will lower the low water mark permanently and augment the range of the tide. It may be safely said at this point that the Mersey Conservancy Commissioners have always looked on any proposed alterations in the tidal basin above Liverpool with exceeding jealousy, as jeopardizing the permanence of the harbor and the maintenance of deep water over the outer bar, and that they will look on this proposed improvement of the basin in a very conservative spirit. From Warrington Bridge it is proposed to widen and deepen the channel of the Irwell to Manchester, cutting off many bends of the river, altogether shortening the distance by about nine miles, making it navigable for vessels of 4,000 tons. The maximum depth of cutting required will be about 45 feet, and the estimated depth of water in the canal at high water deep tides 24 feet. In Manchester there would be a long line of quay wall, the channel between the quay walls being 450 ft. wide, allowing vessels to turn. The bottom width of the canal is to be 72 feet, and its navigation is to be effected by means of steam tugs.

It is calculated by Mr. Fulton, the resurrector of this scheme, that a vessel arriving at Liverpool, three hours before high water will be able to reach Manchester during the same tide. It is expected that the interest on the capital invested will be paid by a tax of ¼ d. per ton per mile or about 2 s. a ton for the whole distance of about 32 miles. On an estimated tonnage of 4,000,000 outward and inward, this would give £400,000 a year. Deducting ⅓ for working expenses would leave £258,000 or the 7 ¾ per cent. or the contemplated outlay.

WE learn from *Nature*, (XIV, 144,) that Dr. Forel lately gave the London Physical Society an account of some observations on periodic waves which take place on the Swiss Lakes (there called "Seiches"). It has long been observed that the waters of these lakes are subject to a rise and fall, more or less regular and which at times has amounted to one or two metres. Dr. Forel has studied this phenomenon in nine different lakes, and finds that it varies with the length and depth of the lake, and is quite analogous to and follows the laws deduced by Prof. Guthrie from experiments on artificial troughs. The apparatus employed was self-registering, very sensitive to the motion of water and yet

so constructed as to eliminate the effect of ordinary waves. At Mongus the duration of the wave was ten minutes while it was seventy minutes at Geneva, owing to the narrowness of the neck of the lake at the latter place. The period proves to be independent of the amplitude, to be least in the shortest lakes, to be lengthened in shallow lakes, etc. Longitudinal and transverse waves may co-exist, just as has been shown by Prof. Guthrie in his trough experiments. This suggests an explanation of a more or less periodic variation in Lake Michigan which has been often observed by the inhabitants of its shores and for which variations of barometric pressure have been suggested in explanation. The same phenomenon was carefully studied on Lake Superior, when it was more fully developed, by the Lake Survey, three or four years since, and the observations compared with barometric readings. with the result, however, of finding no obvious connection between the periodic fluctuations of lake level and barometric pressure. A few months since we had the pleasure of looking over the tide diagrams from the self-recording tide-gauge on the Chicago Crib, two miles out in the Lake. In addition to the well marked tide, of twice a day, there was noticed a curious fluctuation in the curve occurring regularly at periods of about an hour. The only explanation which we could suggest was a horizontal oscillation as a whole, of the waters of the lake alternately from shore to shore. It may be due to the restoring of the normal level of the lake after a storm or disturbance, or possibly to the reflection of the minute tidal wave from shore to shore. It was quite small usually less than half an inch, its chief characteristic being its remarkable regularity. Two or three times within the past three months, remarkable fluctuations have been observed in perfectly calm weather, amounting in one case to nearly three feet. Dr. Forel has probably arrived at the correct explanation.

THE Ottawa, Canada, *Free Press* of Oct. 3d, contains much of interest in regard to the Thunder Bay division of the Canadian Pacific Railway. This section extends from Fort William, on Thunder Bay, to English River, 112 miles. Of this distance, the contract for grading 32 miles west from Fort William is in the hands of Messrs. Sifton. Ward and Farwell, who have already completed 22 miles on which two locomotives are now running. About 250 men are employed upon the remaining 10 miles which will be finished this year. Messrs. Purcell and Ryan have 500 men at work on a section of 72 miles to Savan River and Lac des Mille Lacs and it is expected that the road will be entirely completed to English River by the end of next year. About 900 men in all are employed. Settlers are coming in quite rapidly, taking up the fertile lands in the vicinity of Kaministiqua River and Sunshine Creek. Fort William is a flourishing community of 1200 inhabitants.

THE Salt Lake *Tribune* says that a party under command of Capt. Ericsson have surveyed a portion of the route from Corinne, Utah, to the Snake River, about 100 miles, and that the line is very easy, resembling that of the U. P. along the Platte. Grading was commenced at Corinne on Sept. 25th and will be pushed rapidly forward, and it is expected that the road will be completed to Malade City, about 45 miles, before winter sets in. At Snake River the line will fork, one branch going via the valleys of the Snake & Columbia rivers to Portland, Oregon, and called the Portland, Dallas, and Salt Lake Railway. The Boise people will extend the survey to their place where it will be taken in hand by the Oregonians. Articles of incorporation have been filed at Portland. Oregon, for a company called the Oregon Pacific, with a capital of $1 000,000 which is essentially the same company, or will build a portion of the line on this route. This line will give essentially a new line from the Union Pacific to the Pacific Ocean. It will be strenuously opposed by the Central Pacific which will endeavor to get the Oregon Legislature to revoke the larger land grant to the Portland, Dallas and Salt Lake line, now nearly expired. This is the opinion of the *Oregonian* and the organization of the new company and present activity is undoubtedly to defeat this move and preserve the land grant. The second line will run from the Snake River Junction to Virginia City, and Helena, Montana, and will be called the Utah, Idaho and Montana Railway.

Southern Pacific Railway.

The San Francisco Chronicle gives the following sketch of the Southern Pacific Railway which was opened through to Los Angeles on the 5th inst.: From Merced south the road follows the broad plain on the east side of the San Joaquin some 208 miles, when Caliente is reached. This little town of Caliente is a queer place; it is at the head of a canyon formed by the junction of the coast and Sierra Nevada ranges of mountains meeting and separating out again into what is known as the Caliente hills. The town consists of a few roughly constructed buildings and several Chinese camps. The manner in which the railroad finds its way out of Caliente and to the top of the hills which loom up on the south is surprising, and is a triumph of engineering skill. From the top of the hill the track appears as though it were winding out of a well.

In the first place it circles about and crosses itself in the little valley where Caliente stands; then it takes to the hillside with a steep grade and climbs in a tortuous manner till the crest, some 3,000 feet above, is reached. In one place the road passes through a small tunnel, makes the circle of the crest and passes the ridge again directly over the tunnel through which it first entered, doubling upon itself and making from three to four extra miles to gain from 80 to 100 feet in height. The work on these Caliente hills is of a much heavier character and calling for more skillful engineering than did the work on the Central Pacific. In a distance of ten or twelve miles there were seventeen small tunnels, from 300 to 80 feet in length, cutting through the precipitous crests of the hills. The road-bed was built with great care, and the best of steel rails laid as soon as ties were ready to receive them. As a matter of course the track-laying did not progress very fast, most of the labor being expended in the cutting of tunnels and the building of trestlework. From Tehachap Station southward the road follows a rough country, requiring a great deal of heavy work, till that desolate and God-forsaken stretch of sand and sagebrush known as the Mohave desert is reached. After crossing this desert which is thirty miles or more in width, the route swings off to the right, passing through a canyon into the rough and rugged peak through which the tunnel is driven.

The work of tunneling through the San Fernando mountains was one of the most difficult railroad undertakings attempted in the State of California. The San Fernando tunnel, as it is called, extends nearly due north and south through the San Fernando range of mountains, about six miles north of San Fernando station and twenty eight miles from the city of Los Angeles. It is not cut through a single mountain, as is the case with most undertakings of this kind, but runs through a succession of ridges and canyons. The entire length is 6,964 feet, or nearly a mile and a quarter. This is exclusive of the heavily graded approaches, which aggregate half or three-quarters of a mile more. The deepest point in the tunnel is 600 feet below the top of the mountain. The excavation is made in the form of a trapezoid, only that the top which forms the longest side of the figure, is surmounted by an arch. The width of the bottom is fourteen feet, the height of the sides to the commencement of each sixteen feet, and the height to centre of arch twenty-one feet. The side and top are protected by heavy timbers, braced, fitted and spiked into the aperture as soon as the earth is removed. The south approach ascends at a grade of two feet in 100, until it reaches the mouth of the tunnel, where the road strikes a uniform gradient of 71-100ths of a foot in 100, rising toward the north. At the northern extremity it reaches its highest point, and then descends with the same incline as the southern approach. Work was commenced simultaneously at both ends and at three intermediate points on the line of the tunnel. From these points inclines were sunk to the level of the roadbed to further the work of excavation and provide ventilating facilities when the tunnel was completed. The tunneling was originally started some distance from the present face, but the overlaying earth caved in so badly that it was found necessary to make excavations about sixty feet deep before sufficiently solid earth was found Another obstacle which presented itself was an excessive flow of water, rendering the work of excavation not only dangerous, but very expensive.

Welland Canal Improvement.

The Buffalo *Commercial* says: "Our reports from the line of the Welland Canal indicate that fair progress is being made on the new cut from Thorold to Port Dalhousie. Some delay resulted from the strike in the early part of the season. But since a settlement was made, all the men have continued steadily at work. About 650 stone-cutters are now employed on the canal and at the quarries on Queenstown Heights. The stone comes out of the quarries in very rough, irregular shape, requiring the services of an unusual number of cutters to perform a given amount of work.

"The impression among those employed on the canal is that the stone-work will all be completed next summer. After this is done the ditch can soon be made for the water. Nearly all the earth-work, excavating and grading is finished and the masonry is well advanced. Eleven locks are built up to the coping. Campbell & Co., who hold the contract for section four, are well along with the heavy work at the Welland Railway crossing. The large swing-bridge on section seven is finished. The tunnel under section eleven is practically done. Lobt & Co., contractors for section twelve, are now engaged on their tunnel. It will be finished in ample time. The other locks are in various stages of advancement. If the men can be kept at work without interruption the prospect is good that the entire canal will be ready for business by the time specified in the contracts."

Origin of our Great Lakes.

An exchange says:—Among the most interesting of the scientific papers presented at Buffalo was the one of Prof. Newberry in regard to the origin of our great lake chain. He tells us that at one time Ontario, Erie and Huron apparently formed portions of the valley of a river which subsequently became the St. Lawrence, but which then flowed between the Adirondacks and Appalachians, in the line of the deeply buried channel of the Mohawk, passing through the trough of the Hudson and emptying into the ocean eighty miles southeast of New York. Lake Michigan was apparently then a part of a river course which drained Lake Superior and emptied into the Mississippi, the Straits of Mackinaw being not yet opened. After that, it would appear, came the "cold period," when huge ice glaciers were formed in the mountains above what is now the lake-chain, and moving southward, scooped out the lakes from a plateau previously existing there, gradually broadening their basins by grinding away their southern margins with an inconceivable power. At length the intense cold period passed, and the glaciers which had before flowed over the watershed in Ohio was so far reduced as to be unable to overtop its summit, but, deflected by it, flowed along its base, spending its energies in cutting the shallow basin in which Lake Erie now lies.

The Professor goes on to say that this melting of the glaciers was accompanied, perhaps occasioned, by a sinking of the continent, which progressed until the waters of the Atlantic flowed up the valley of the St. Lawrence to Kingston, and up the Ottawa to Arnprior. The valleys of the St. Lawrence and the Hudson were connected by way of Lake Champlain, and thus the highlands of New England were left as an island. It is also possible that the sea water penetrated to the lake basin through the valley of the Mohawk and through that of the Mississippi, but of this we have no evidence in the presence of marine fossils.

NOTES.

There is at length a prospect of the industrial survey of India being taken in hand.

Eherenberg, the eminent microscopic investigator of Berlin, died on the 27th of last June.

Capt. Jno. V. Gould, for many years City Engineer of Paduca, Ky., died in that city on the 25th ult.

The Krupp establishment at Essen, Germany, employs 15,500 workmen in all departments, including its mines.

John G. Meigs has contracted with Bolivia for a twenty years' lease of all its nitrate deposits, paying an annual rental of $10,000.

Steps are being taken at Dubuque to push forward

the building of the pontoon bridge at that point as speedily as possible.

The great bridge across the Danube on the Prater, at Vienna, will be opened for traffic on the 21st inst. Its construction has cost more than 3,500,000.

There is a saw-mill in British Columbia that cuts 13,000,000 feet of lumber annually. The product is largely shipped to S. America, Australia, and China.

The machinery for the manufacture of wood paper hangings has been so perfected that two hundred thin leaves can be slit from an inch of maple or other fine grain wood.

Colorado is at work on a narrow gauge road from Floyd Hill, terminus of the Colorado Central to Idaho and Georgetown, with a branch to Central City that will be extended into the Middle Park.

A company was organized on Oct. 2, in this city to build a narrow-gauge raitway from Chicago to Waukegan, about 36 miles. It is to be called the North Shore Railway and the capital is fixed at $250,000.

The *Northwestern Lumberman* says that Cypress is growing into great popularity in the southern and eastern markets, being well adapted and largely used for finishing purposes and the manufacture of sashes, doors, and blinds.

The National Tube Works Company of Boston, has the contract for 300 miles of 4-inch pipe, from the Pennsylvania Transportation Company, now building the pipe-line to the seaboard. They build an enameled cap-welded pipe, largely used in hydraulic mining on the Pacific slope.

Next season the Providence and Stonington Company will put on their line a new steamer named the Massachusetts. She is of 3,000 tons, 325 ft. long at the water line, 46 ft. beam or 76 ft. over all, and 15½ ft. depth of hold. She will be finished like the other handsome boats of this line.

The highest trestle bridge on the Pacific Coast is the one in course of construction across Brown's Canyon, two miles northwest of Freestone, in Sonoma county, on the line of the North Pacific Coast Railroad. It will be 135 feet in height from the bed of the canyon, and 600 feet in length.

The *American Journal of Science* states on the authority of Mr. Bell, as the result of the Canadian Pacific Surveys, that the hight above sea-level of Lake Winnipeg is 710 feet; St. Martin's Lake, 737 feet; Lake Maritoba, 752 feet; Lakes Winnipegosis and Cedar, 770 feet; Lake of the Woods, 1,042 feet.

A Geodesic Congress is to be held at Brussels this month, under the presidency of Dr. Boyer, and it is hoped that one very important question may be settled. This question is that of the configuration of the earth' and the best means of determining it—a matter which interests navigators in the highest degree.

During the last twenty years the British Government has added 573 ships to the navy by building, and has purchased 44 more. It has sold 110, broken up 125, and 31 have been lost. The number of Gatling guns in use is being rapidly increased. The large ironclads are now armed with them, and several have been lately sent to Malta.

An Admiralty notice in the London *Gazette* announces that, in consideration of the special and valuable services rendered by Lieut. Cameron to the cause of science in his recent successful journey of exploration in Africa, he has been promoted to the rank of Commander in Her Majesty's fleet, such promotion being special and in excess of the authorized numbers.

It is claimed by the English that last year they completed the longest bridge in the world, in their East India possessions. It consists of sixty-four spans of 142 feet each, thus 9,300 feet, or more than one and three-quarter miles long. It is all built of brick and iron; the masonry amounts to 5,000,000 cubic feet, while the iron girders weigh 6,000 tons.

The Commissioners of Public Works of Chicago on Oct. 10, approved the bond of J. B. Smith for paving Twenty-second street from State to Arnold streets, and for paving West Sixteenth street; the bond of H. L. Hawley, for paving Haddock place from Clark to La Salle streets; and the bond of McGinniss & Naylor, for placing smoke consumers under the boilers of the City Hall.

A Spanish capitalist advocates the connection of Africa and Europe by a tunnel under the Straits of Gibralter. He desires to obtain for the enterprise $20,000,000, and says that, with this tunnel and the one between Calais and Dover completed, the railroad companies might soon be advertising that they would take passengers from London to Calcutta "without change of cars."

A telegraph wire has been put across the East River at the Brooklyn Bridge for the purpose of transmitting messages in connection with the erection of the temporary works and permanent cables. Eleven little offices about four feet squrae are placed on the anchor piers, towers, etc., for the purpose of receiving and transmitting messages. The first cradle rope for the temporary work, weighing about 40,000 lbs. was delivered Oct. 5.

It is a pleasure to note the prosperous condition of the Milwaukee Bridge and Iron Works. They employ 115 men, and are now building the Humboldt avenue bridge near our city; also getting out iron-work for five bridges on the Wisconsin Central Railway, three bridges for the Pennsylvania Rail oad Company, and have the contract for the inlet-pipe and crib for Evanston, Ill., as also a contract for a 300-foot draw-span for the Minnesota River.

We learn from the *Engineering and Mining Journal* that the Bethlehem Zinc Company having contracted for 12,000 tons of ore per year, for five years, from the New Jersey Company, have decided to abandon the Friedensville mines, on account of the expense for pumping, which amounts to $4.00 per ton of ore. The pumps employed at this mine were among the largest mining pumps in the world lifting some 30,000,000 galls. of water per day.

The Rockford, Ill,, *Journal* says:—A company of government surveyors pitched their tent in the East side park on Wednesday. There are in the party two observers and one assistant. Lieutenant C. F. Powell is the leader of the expedition. The object of the survey is to ascertain the magnetic elements of this region. These observations are being taken in the interest of navigation and the science of magnetic currents. Observations had been taken at St. Paul, Wabesha, La Crosse and Galena, before the party came here. They will remain about a week.

The staff of John Hopkins University, at present consists of the president, six professors, twelve associates and twenty fellows. They have been engaged in examining candidates for admission the number of which, far exceed expectations, many college graduates having applied for instruction in the laboratories. Lectures have already commenced and will be continued throughout the winter, courses being given by Lowell, Child, Whitney, Walker, Hilgard, Newcomb, Mallet, and others. These lectures are open to ladies and gentlemen not connected with the University.

Paris owes much of its good health to a lavish use of water. Besides the reservoirs of Menilmontant and Montsouris, there are sixteen other reservoirs on a small scale, where water is collected before being forced through the 1,500,000 metres of pipes which extend into even the smallest streets and passages in the city. In the squares and public places there are fountains which play daily, refreshing the air. There are sixty-one in all. For the washing of the streets and boulevards, there are, in addition to the 725 hydrants, 4,593 water jets, which the employees have the keys of, and which are opened every day in order to sprinkle the streets and wash out the gutters, Every morning fresh water is thus made use of. There are 2,820 pipes used for sprinkling the streets and pavements, and an immense number of sprinkling machines drawn by horses.

There has been recently incorporated in Boston an association of teachers and others interested in the introduction of the Metric weights and measures, under the name of the American Metric Bureau. Art. 2 of its constitution reads as follows:—"The object of this Bureau shall be to disseminate information concerning the Metric System; to urge its early adoption; and to bring about actual introductions wherever practicable. To this end it will secure the delivery of addresses; publish articles; circulate books, pamphlets and charts; distribute scales and measures; introduce the practical teaching of the system in schools; and in all proper ways, as far as the means at its disposal will allow, the Bureau will urge the matter upon the attention of the American people till they shall join the rest of the world in the exclusive use of the International Decimal Weights and Measures." This Bureau already includes among its members many of our prominent educators, and its numbers are rapidly increasing. An office has been opened at 13 Tremont place, Boston, and as soon as suitable arrangements can be made, branch offices are to be opened in New York, Philadelphia, Chicago, and other central localities, where all persons interested are invited to call or to write freely in regard to any matter pertaining to the work of the Bureau.

Railway News.

A new survey of the Texas Pacific has been ordered from San Diego, Cal., to Fort Yuma.

There is talk of extending the Eureka & Palisade road (Nevada) south to the Colorado River, about 250 miles from Eureka.

A road is proposed from Waco, Texas, eastward through Fairfield to Palestine, 90 miles. Money has been raised for a preliminary survey.

A narrow-gauge road is proposed from Monocacy Station, on the Philadelphia and Reading Railway, Penn., 10½ miles south of Reading to Olny.

The railroad bridge across the Mississippi river at La Crosse, Wis., is chargeable with inducing more profanity among the raft-riders than any other "snag" on the river.

The Southern Pacific Railway has commenced a section of 49 miles extending westward from Goshen to Los Gatos across the San Joaquin Valley north of Tulare Lake.

It is expected that the Texas Pacific Railway will be extended from Fort Worth to Weatherford, Tex., by June, 1877. There are some heavy grades on this portion of the line.

Track is now laid 45 miles north from Yarmouth, N. S., nearly to the Sissipoo River. A force has recently been put on the northern end of the line between Digby and Annapolis.

The C., R. I. & P. R. R. Company have a corps of engineers at work surveying preliminary lines for an extension of their road into Guthrie, Shelby and Audubon counties, Iowa.

The narrow-gauge road from Columbia to Lewisburg, Tenn., 21 miles, will soon be in running order. Its extension to Fayetville and thence to Huntsville, Ala., is in contemplation. This is a part of the through line from St. Louis, via Cairo, to the Southeastern seaboard.

The Atchinson, Topeka and Santa Fe Railway are to build a branch, commencing 15 miles west of Emporia, to the Indian Territory line, 100 miles. through Chase, Butler and Cowley Counties. A branch to Eureka, Butler County, 22 miles, is also projected.

Work in the railroad tunnel near San Rafael is progressing satisfactorily, all the men who could work to advantage being employed. At the south end four feet per day are made, and at the north end three feet. The progress made in September will be much greater than in any previous month.

The grading on the Austin extension of the International and Great Northern Railway is now completed from Round Rock, the present terminus, to Duval, Texas, 11 miles and track-laying is in progress. Trouble in regard to night pay delays the work between Duval and Austin.

The grading of the New Orleans Pacific Railway is now completed for 40 miles west of Alexandria, La., and about 600 men are at work. The line from Alexandria southeast to Bayou Gonla, where connection is to be made with the New Orleans, Mobile & Texas road, is well on toward completion.

A new bridge has been determined upon at Cedar Rapids, Iowa, to cross the Cedar River just below Ivanhoe Ferry. The estimated cost is $21,000. The bridge will consist of four spans of 120 ft. each, and is to be 16 ft. wide. Plans and specifications are now preparing and in a short time bids will be received. It is expected to let the contract in the November meeting of the Supervisors.

The Centennial Exhibition.

BY C. J. MOORE, C. E.
[Written for Engineering News]

INTRODUCTORY.

PHILADELPHIA, Sept. 29, 1876.

One's first impresssion after inspecting the principal buildings of the Exhibition is that of the neatness and appropriateness of their design and the eminently good taste of their decoration. With the exception perhaps of Agricultural Hall, they are all of fine appearance and some, really handsome buildings. Notably Horticultural and Memorial Halls; the general effect of the latter being good though the design is rather poor in its detail, and conventional. In decorating with color the true principle has been followed of emphasizing the principal lines of construction and in colors of a subdued tint; the eye is never offended with glaring contrasts or inharmonious similarities of color; buffs, greys, mixed blues and reds, and browns, all of various hues have been used universally, and the resulting effect is very pleasant to the eye; pure colors and strong contrasts would not have been so agreeable and would have tended to fasten the eye upon them rather than on the objects exhibited. The Main Building and United States Building are specially noticable for the general good taste of their decoration; the eye is never forced from an inspection of the objects exhibited to the various features of the buildings in which they are placed, but should such inspection be made it is invariably satisfactory whether one looks at wall spaces, at roof lines, at columns, at skylights, panels or what-not.

It is unnecessary in this journal to give a full description of the principal buildings for which the reader may be referred to many previous notices, chiefly those in *Engineering* during last year and the early part of this, but it will be convenient here to give a few particulars concerning them, and the classes of their contents.

The Main Building is in the form of a parallelogram 1,880 ft. long by 464 ft. wide, 45 ft. high to the cornice and 75 ft. to the ridge of the roof inside. There are four towers 75 ft. high on the corners of the building, and between the towers and the central projections there is a lower roof introduced of 24 ft. in height at the cornice. The roof over the central part for 184 ft. square is raised above the surrounding portion, and four towers 48 ft. square surmount the corners to a hight of 120 ft above the ground. The total area enclosed by this building is 21.47 acres including 20.02 acres in the ground floor, 85 acres in the upper floor projections and .60 acres in the upper floors of the towers. The main promenades (one longitudinal and one transverse) are each 30 feet wide, and those through the centre of side avenues and transepts are 15 ft. wide, all other walks are 10 ft. wide The columns supporting the roof trusses are of channel bars with plates rivetted to the flanges and range in length from 23 ft. to 125; they number 672 in all, are spaced 24 ft. apart longitudinally, and have an aggregate weight of 2,200,000 lbs. The roof trusses of an ordinary form and girders weigh in the aggregate 5,000,000 lbs. The cost of the building was $1,580,000; the ground was graded and foundation laid in 1874, erection of ironwork commenced May 8th 1875, and building completed Feb. 14th 1876. The building was designed by H. Pettit and Jos. M. Wilson, contracted for by R. J. Dobbins, ironwork manufactured by Wm Sellers, & Co., and erected by the Watson Manufacturing Company.

Most of the varied products of 30 different nations are displayed in this building and its annexes, which come under the heads of the first three out of the seven departments in which all exhibits are included, viz: 1st, mining and metallury (subdivided into 30 classes), 2nd, manufactures (96 classes) and 3rd, education and science (50 classes). If all of the exhibits in these departments could be found in this building examination and comparison would not be very difficult, but unfortunately they are scattered about in various other buildings and a comparison of the various exhibits in one department as for instance mining and metallurgy necessitates a hunt through more than a dozen different buildings in various parts of the ground; this is one of the few defective points in the arrangement and management of the Exhibition.

The next largest building is Machinery Hall, similar in design to the main building but decorated in somewhat plainer style and with lighter tints. Its length is 1,402 ft., bredth 360 ft., height to the cornice 40 ft. and to the ridge of the roofs or ventilators 70 ft. inside, and the plan is that of two main avenues with a central aisle between and an aisle on either side. At the centre of the building is a transept 268 ft. long by 90 ft. wide, containing a tank 160×60 ft. with 10 ft. depth of water with a waterfall 35 ft. high and 40 ft. wide supplied from the pumps on exhibition;—this transept forms the hydraulic annex. The columns supporting the roof trusses are placed in general 16 ft. apart and at a hight of 20 ft. are fixed the hangers supporting the main lines of shafting, 8 in number, running almost the whole length of the building and driven by the now famous Corliss Engine of 1,400 horse power. The building was commenced at the close of January 1875 and finished on October 1st, and cost $542,300; the exhibition area amounts to about 14 acres. The design was made by the same engineers and architects as the main building and erected by the contractor Philip Quigley, of Wilmington, Del.

The number of nations exhibiting in this building and annexes is 14, and their exhibits are divided into 100 classes, and the machinery of no less than 15 others is exhibited either wholly or in part in the main building, and railway plant, cars etc., for all countries chiefly in the carriage annexes to the Main Building, and here is another instance of the defective arrangement before mentioned which perhaps is not wholly the fault of the Bureau of Installation who had to consider the expediency of the moment rather than the conveniences of special correspondents in making their arrangements.

Agricultural Hall is a parallelogram 820×540 ft. and consists of a long nave crossed by three transepts all covered with Howe truss arches of gothic form. The spaces between the transepts and nave are also trussed over but in another style and the effect of the whole is incongruous and one upon which the architect cannot be congratulated. The area included is 10.16 acres; the building was commenced at the end of July 1875 and completed in April this year at a cost of $260,000. It was designed by Jas. H. Windrim, contracted for by the same contractor who built Machinery Hall, and erected by Bell Bros.

The exhibitions in this building and its three adjacent annexes are: 1st, the wagon, 2nd, brewers, and 3d pomological buildings comprising 21 nations, and their exhibits are divided into 100 classes.

The Horticultural is one of the most successful buildings on the grounds, both in design and erection and is intended to be permanent the cost $300,000 being paid by the city of Philadelphia. It is mainly composed of iron and glass, is in the 12th century Moresque style of architecture, and measures 383×193 feet. The main floor is occupied by the central conservatory 23×80 ft. and 55 ft. high surmounted by a lantern 170×20 ft. and 14 ft. high. A gallery five feet wide and 20 ft. from the floor runs all around this conservatory. On the north and south sides of this main room are four forcing houses each 100×30 ft. covered with carved roofs of iron and glass. Dividing these forcing houses in the center of each side is a vestibule 30 ft. square, and there are similar ones in the centers of the east and west sides with various offices on each side thereof. From these vestibules ornamental staircases lead to the internal galleries and to the four internal galleries which are each 100×10 ft., surmount the roof of the forcing houses, and form a promenade of 1,800 sq. yds.

There are terracees 80×20 ft. at each end and two kiosques, and in the interior eight ornamental fountains. The building was commenced May 1st, 1875, and completed on the first of last April, it covers an area for exhibition purposes of 122,500 sq. feet, was designed by H. J. Schwartzman, and contracted for by John Rice. The numbers of nations contributing are 16, and their exhibits are divided into 40 classes; this section may be said to be in some respects the least satisfactory of all the Exhibition.

Memorial Hall containing 75,000 squar efeet of wall space for paintings and 20,000 sq. ft. of floor space for statues, etc., and the art annex containing 60,000 sq. ft. of wall space and a large area for statues, etc., are both intended to be permanent buildings, the former to be used as an Industrial Art Museum, and they were built at the joint cost of the State of Pennsylvania and the City of Philadelphia. The architect of the memorial hall, Mr. Schwarzman, is not quite so successful here as in his Horticultural Hall, for though the general effect of the Hall with its sixteen fold gilded spread-eagleism and its "colossal bull" surmounted by Columbia is fair, yet the details are very conventional and familiar in many another place and the scale of the eagles is too large for height above the ground. The building measures 365×210 ft., and 59 ft. high, on a basement of 12 ft., and over the central portion a dome much flattened in outline rises to a height of 150 ft. above the ground. The hall is built of a fine white stone of good texture, and cost $1,500,000; in the interior a hall is designed 287×83 ft., capable of seating 8,000 persons, but at present this is cut up by partitions into various smaller rooms and galleries for the purpose of obtaining more wall space for the pictures, and this perhaps accounts for the ventilation at present in this building being decidedly defective. The space being insufficient for pictures accepted, the art annex was designed; from whose ingenious brain this collection emanated, of 30 cubical rooms, each 40 ft. sq., 4 galleries each 100×54 ft. and two corridors each 160×20 ft. we are unable to state; it is unique, and as described by another critic "labyrinthine", and the outlines of its plan number 20 different walls; it reminds one of a collection of weaving sheds more than anything else. The annex is built of brick covered with plates or stucco colored light gray so as to harmonize with the neighboring Memorial Hall. The art exhibits are divided into 60 classes, 12 nations exhibit in Memorial Hall, and 15 in the annex.

Space will not allow of a detailed description of the buildings and structures, over 180 in number, contained within the grounds of the exhibition nor of their contents, but the main point of view from which they will be considered in these articles is one general and special though not detailed, on which a comparison will be made between the engineering and analogous exhibits of other nations and our own, and also of the respective technical educational systems and their practical results. Some foreign nations have given us a good opportunity of making such comparison which can only result in advantage to ourselves, and with the aid of a little French, German and Spanish one is able to gather much useful information from the foreign representations and attendants present, who are all friendly, courteous, and ready to afford any information in their power.

The exhibits of natural and finished products of various nations, so far as interesting to an engineer (*e. g.* minerals, metallurgy and machinery) wil also be passed in review in due course.

An interesting event, no doubt to many of the subscribers of ENGINEERING NEWS took place on Wednesday evening the 27th inst.—the announcement of the awards to the representations of the various nations in the Hall of the Judges Pavilion, and by the courtesy of the Bureau of Awards, your correspondent is enabled to prepare the subjoined lists from galley proofs of the lists of successful exhibitors who are all (including the Live Stock Exhibition) grouped into 34 classes. The comparative popularity of different nations as they were called forward one by one to receive their awards was well manifested, Brazil and Great Britain were the most popular, the former receiving three cheers and the latter six! A correct list of the judges is not yet obtainable; as soon as it can be had a list of those groups in which the subscribers of the NEWS would be interested will be published.

Judges Awards.

LIST OF AWARDS TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS AND THOSE EXHIBITING UNDER THEIR AUSPICES.

GROUP 1.—Minerals, Mining and Metallurgy including the Machinery, Metals, Metallurgical Products and Processes, Machines, Tools, and Apparatus of Mining and Metallurgy, Mine Engineering, Models, Maps, and Sections.

*Barnum, Richardson & Co., Lime Rock, Conn.,—Pig Iron for car wheels.

Cambria Iron Co., Johnstown, Pa.,—Raw materials for iron manufacture, Iron, and Bessemer Steel rails and bars.

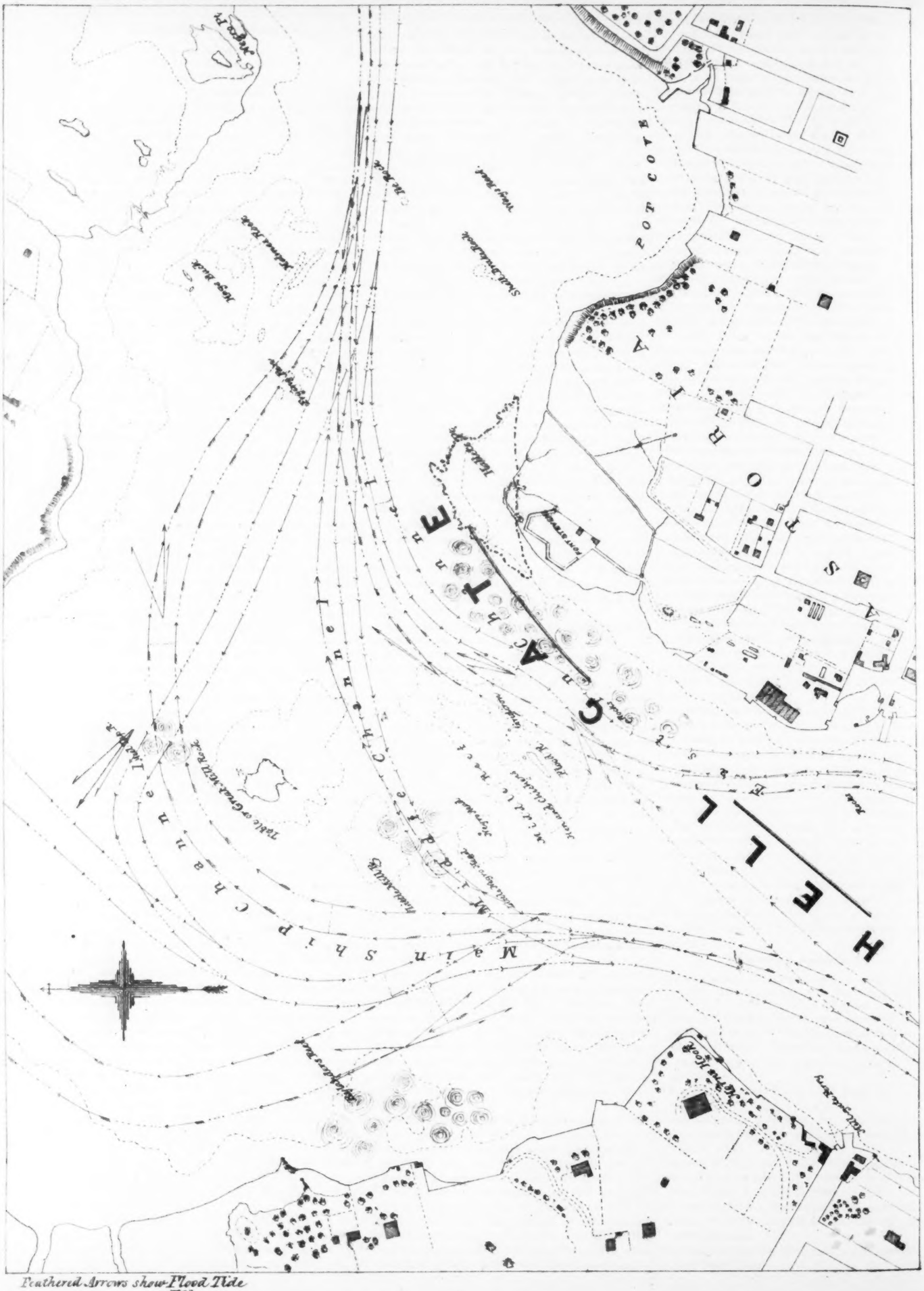
Cogswell, W. B., Mine La Motte, Mo.—Lead Ore.

Edgar Thompson Steel Co., Pittsburgh, Pa.—Bessemer Steel, Ingots, Rails and Forgings.

Keystone Bridge Co., Pittsburgh, Pa.—Iron for bridges.

Morris, J. P., & Co., Philadelphia, Pa.—Blowing Engine for Blastfurnace.

Otis Iron and Steel Co., Cleveland, O.,—Siemens-Martin Steel Boiler Plate.


POT COVE
Middle Ground
Middle Ground
Middle Ground

HELL-GATE & VICINITY.

GROUND PLAN OF EXCAVATION.

Scale 100 ft. = 1 Inch.

Fort Stevens

Flushing

Old Ferry

College Pt.

Hunts Pt.

Ward's I.

Berrian's I.

FLUSHING BAY

Harlem R.R.R. Bridge

Brooklyn

S. Brooklyn

Astoria

Ravenswood

Hallett's Point

WILLIAMSBURG

EAST RIVER

Navy Yard

CITY OF NEW YORK

BROOKLYN

HUDSON R.

Bills Ferry

HOBOKEN

JERSEY CITY

Paulus Hook

Governor's I.

Hallett's Cove

Astoria

GOWANUS BAY

Flats

Buttons

Bay No.

Pennsylvania Steel Co.. Harrisburg, Pa.—Objects of Steel and Steel Ingots.
Philadelphia & Reading R. R. Co., Reading, Pa.—Iron Rails and Rail Piles.
Phœnix Iron Co., Philadelphia, Pa.—Rolled Iron Beams, Columns, and Shapes.
*Roots, P. H., & F. M., Connersville, Ind.—Rotary Power Blower.
Union Iron Co., Buffalo, N. Y.—Wrought Iron Beams.
Union Iron Mills, Pittsburgh, Pa.—Rolled Iron Shapes.
*Witherbee, J. F., Port Henry, N. Y.–Combined Water-Block Tuyere and Nozzle for Blast Furnaces.
Wood, De Volson, Hoboken, N. J.—Rock Drills.

GROUP 2.—Pottery, Glass, Artificial Stone, &c.

Wampum Cement and Lime Co., Newcastle, Pa.—Portland Cement and Artificial Stone.

GROUP 14.—Apparatus of Heating, Lighting, Ventilation, Water Supply and Drainage.

Bowditch, Ernest W., Boston, Mass.—Plans for Rural Parks for Boston, Mass.

GROUP 18.—Railway Plant, Rolling Stock and Apparatus, Road Engines.

*Barnum, Richardson & Co., Lime Rock, Conn.—Cast Chilled Car Wheels.
Burnham, Parry, Williams & Co., Philadelphia, Pa.—Locomotives.
Danforth Locomotive Works, Paterson, N. J.—Locomotive and Plantation Engines.
Dickson Manufacturing Co., Scranton, Pa.—Passenger and Mine Engines.
Mason Locomotive Works, Taunton, Mass.—Locomotive Engine.
New York Central R. R. Co., N. Y. City.—Postal Car.
Pennsylvania R. R. Co., Altoona, Pa.—Postal Car, Railroad Track, Railroad Switches.
Philadelphia & Reading R. R., Reading, Pa.—Locomotives.
Rogers Locomotive and Machine Works, Patterson, N. J.—Wood Burning Locomotives.
*Wharton Railway Switch Co., Philadelphia, Pa.—Safety Switch and Unbroken Track.

GROUP 19.—Vessels and Articles of Transportation, (not included in other groups).

American Dredging Co., Philadelphia, Pa.—Dredging Machines.
John A. Roeblings' Sons, Trenton, N. J.—Wire Ropes.

GROUP 20.—Motors, Hydraulic and Preventive Apparatus, &c.

Birkenbine, H. P. M., Philadelphia, Pa.—Fire Protection Apparatus.
Birkenbine, John, Phila., Pa.—Treble Fire Hydrant.
Dudgeon, Richard, New York City.—Hydraulic Jacks and Punches.
Gun Powder Pile Driving Co., Philadelphia, Pa.—Gun Powder Pile Driver.
John A. Roebling's Sons, Trenton, N. J.—Wire Rigging &c.
Leavitt, E. D., Lawrence, Mass.—Drawings of the Lawrence Pump Engine.
Morris, J. P., & Co., Philadelphia, Pa.—Blast Engine.
*Paulding Keith & Co., West Point, N. Y.—Model of Davey Pump Engine.
Sawyer, Edward, Boston, Mass.—Drawings of Boyden Fourneyron Turbine.
*Stout, Mills & Temple, Dayton, O.—Turbine Wheels.
Worthington, H. R. & Co., N. Y. City.—Steam Pumping Engines.

GROUP 25.—Instruments of Precision, Research Experiment and Illustration, including Telegraphy and Music.

Grant, Geo. B., Boston, Mass.—Tabulating Calculating Machine "Difference Engine."
Henry, D. Farrand, Detroit, Mich.–Current Meter, and Inlet Pipe and Strainer for Water Works.

GROUP 26.—Architecture and Civil Engineering.

Clarke, Reeves & Co., Philadelphia, Pa.— Girard Ave. Bridge across the Schuylkill River at Philadelphia.
Meiggs, Gen. M. C., Washington, D. C.—Plans of Washington Pipe Aqueduct & Cabin John Creek Bridges.
Shedd, J. Herbert, Providence, R. I.—Hydrant with all the necessary appurtenances.

GROUP 28.—Industrial and Architectural Designs, Models and Decoratives, etc., etc.

The American Society of Civil Engineers, United States.—A very large Collection of Models, Plans, Drawings, Photographs, and various Publications illustrating the work of the Society and the progress of Engineering.

GROUP 29.—Horticultural and Landscape Gardening.

*Weidenmann, J.,—New York City.—Plans for Improving Grounds.

Note.—Those names to which an asterisk is prefixed are not members of the Society, but exhibit under the auspices of the same.

AWARDS TO MEMBERS OF THE AMERICAN INSTITUTE OF MINING ENGINEERS, AND INCORPORATED COMPANIES CONTAINING MEMBERS OF THE SAME.

GROUP 1.—

Albany & Rensselaer Iron & Steel Co., [*R. W. Hunt, D. A. Wendell.*] Troy, N. Y.—Bessemer Steel and Wrought Iron Rails, Bars, Forgings, Angles, Spikes, Nails and Horseshoes.
Bouve, T. T., Boston, Mass.—Polished porphyries from Massachusetts.
Bradford H., Philadelphia, Pa.—Quartz rock.
Burden & Sons, H., [*J. A. Burden*] Troy, N. Y.—Wrought Iron Bars and Horse Shoes.
Cambria Iron Co., [*D. J. Morrell, John Fulton, D. N. Jones,*] Johnstown, Pa.—Raw Material for the Iron Manufacture and Iron and Bessemer Steel Rails and Bars.
Chemical Copper Co., [*T. Sterry Hunt, D. Douglass Junr,*] Phœnixville, Pa.—Copper Ores and Products.
Clark, Ed., Great Western Quicksilver Mine, Lake Co., Col.—Quicksilver Ores.
Cleveland Rolling Mill Co., [*A. B. Stone, H. & W. B. Chisholm, S. C. Baldwin,*] Cleveland, O.—Bessemer Steel and Siemens-Martin Steel Rails, Forgings, etc.
Coggswell, W. B., Mine La Motte, Madison, Mo.–Lead Ores,
Cooper, Hewitt & Co., [*A. S. Hewitt, Ed. Cooper, R. W. Raymond,*] New York City.—Wrought Iron Beams, Bars, Chains, and Wire.
Coxe Bros. & Co., [*E. C. Coxe,*] Yeddo, Pa.—Model of a new Coal Breaker, Buildings and Dressing Apparatus, and a Coal Breaking Machine.
Edgar Thompson Steel Co., [*W. P. Shinn, W. R. Jones, H. C. Walton,*] Pittsburgh, Pa.—Bessemer Steel Ingots, Rails and Forgings.
Edgemoor Iron Co., [*Wm. Sellers,*] Philadelphia, Pa.—Rotary Puddling Furnace, and Links for Bridges.
Garrison, A., & Co., Pittsburgh, Pa.—Chilled Rolls.
Gaujot, E., Michigan.—Copper.
Goodfellow, Dr. J. M., Cornucopia District, Nev.—Silver Ores.
Hill, S. W., Marshall, Mich.—Native Copper.
Hitchcock & Blake, [*W. P. Blake*] Hanover, N. H. and New Haven, Conn.—Geological Maps.
Jones & Laughlin, [*H. A. Laughlin*] Pittsburgh, Pa.—Cold Rolled Wrought Iron Shafting.
Keystone Bridge Co., Pittsburgh, Pa.—Iron for bridges.
Lackawanna Iron and Coal Co., [*W. W. Scranton*] Scranton, Pa.—Bessemer Pig Iron and Wrought Iron Bars.
Lehigh Zinc Co., [*B. C. Webster,—Clerc*] Bethlehem, Pa.—Ores, Spelter, Sheet Zinc and Zinc Oxide.
Loiseau Pressed Fuel Co., [*E. F. Loiseau*] Philadelphia, Pa.—Compressed Fuel.
Midvale Steel Works, [*Wm. Sellers*], Nicetown, Pa.—Tubes, Bars, Forging and Castings of Crucible and Siemens-Martin Steel.
Miller, Metcalf & Parkins, [*R. Miller, Wm. Metcalf*] Pittsburgh, Pa.—Crucible Steel for Tools.
Niblock, Zimmerman and Alexander (*J. S. Alexander*) Brazil, Ind.—Compressed Air Coal-Cutting Machine.
Otis Iron and Steel Co. (*S. T. Wellman*) Cleveland, O.—Siemens-Martin Steel Boiler Plate.
Park Bros. & Co. (*J. Park Jr.*) Pittsburg, Pa.—Crucible Steel Boiler Plate and Bars.
Parsons, C. B., St Joe Mine, St. Francois Co., Mo.—Mass of Galena.
Passaic Zinc Co., New York City—Ores, Spelter, Sheet Zinc and Castings and Zinc Oxide.
Pennsylvania Lead Co. (*E. F. Eurich*) Mansfield Valley, Pa.—Refined Lead.
Pennsylvania Steel Co. (*C. O. Parsons*) Harrisburg, Pa.—Steel and Steel Ingots.
Philadelphia and Reading R. R. Co. [*W. E. C. Cone, W. Lorenz, T. B. Gowen*] Reading, Pa.—Iron Rails and Rail Piles.
Phœnix Iron Co. [*T. C. Clarke*] Philadelphia, Pa.—Rolled Iron Beams, Columns and Shapes.
Pottstown Iron Co. [*M. P. Janney*] Pottstown, Pa.—Wrought Iron Plates and Bars.
Rand, T. D., Philadelphia, Pa.—Minerals.
Reese, Graff, & Woods [*J. Reese*] Pittsburg, Pa.—Wrought Iron and Steel Bars and Horseshoes.
Schuylkill Copper Co. [*C. M. Wheatley*] Phœnixville, Pa.—Copper and Copper Ores.
Shelby Iron Co., Alabama,—Pig Iron.
Tatham & Bro. [*W. B. Brodie, Kirchhoff Jr.*] Philadelphia, Pa.—Sheet Lead and Tin-lined Lead and Iron Pipes.
Taws & Hartman [*J. M. Hartman*] Philadelphia, Pa.—Blast Furnace Apparatus.
Union Iron Co., Buffalo, N. Y.—Wrought Iron Beams
Union Iron Mills, Pittsburg, Pa.—Rolled Iron Shapes.
Washburn & Moen Co. [*C. H. Morgan*] Worcester, Mass.—Iron and Steel Wire.
Weimar Machine Works [*P. L. Weimar*] Lebanon, Pa.—Blowing Engines and other Blast Furnace Machinery.
Wilder, J. T., Chattanooga, Tenn.—Collection of Marble and Ores.
Witherbee, T. F., Port Henry, New York—Combined Water-Block Tuyere and Nozzle, for Blast Furnaces.
Woodstock Iron Co. [*A. L. Tyler*] Anniston, Ala.—Iron Ores, Pig Iron for Car Wheels, and Spiegel.

GROUP. 18.—Pennsylvania Steel Co., Philadelphia, Pa.—Railway Switches.

Philadelphia and Reading R. R. Co., Reading, Pa.—Locomotives.

GROUP. 20.—Birkenbine, John, Philadelphia, Pa.—Treble Fire Hydrant.

Sellers, Wm. & Co., Philadelphia, Pa.—Injector.
Sellers, Wm. & Co., Philadelphia, Pa.—Shafting Couplers & Hangers
Jones & Laughlin, Pittsburg, Pa.—Shafting, Hangers, Pulleys, etc.
Marion Machine Works, Lebanon, Pa.—High Speed Blowing Engines.

GROUP. 21.—Machine Tools—Wood, Metal, and Stone.

Burden, H. & Sons, Troy, N. Y.—Horseshoe Machine Model.
Sellers, Wm. & Co., Philadelphia, Pa.—Steam Hammers and Machine Tools.

NOTE.—The names of members of the Institute in companies which have received awards are indicated by italics and enclosed in brackets.

A supplemental list of awards containing a few additional names will shortly be printed by the Commission, and also the correct list of the judges which will both be transferred to this journal so far as interesting to its readers.

The Cost of the British Museum.

The Trustees of the British Museum have just issued a return of the total expenditure on that institution since its foundation in 1753 up to the end of March, 1875, nearly a century and a quarter. The charges are classified under their distinct heads, and show the entire expenditure during that period, with the following interesting results, For the staff and the buildings together, $18,108,655; for new buildings and repairs, $6,500,425; for rates and taxes, $207,360. The charge for the staff alone during the entire period, for salaries, wages, police, and pensions is $7,369,935 (this item in 1874-'5 reached the sum of $275,080). From the staff and building charges also must be deducted the cost of bookbinding and preparing and printing the catalogues, etc., all of which is executed on the premises, and also the sum of $32,080 for the publication of the cuneiform inscriptions. In contrast to the seemingly enormous sums expended on the staff, etc., is the comparatively small sum expended on the collection itself. During the corresponding period the entire cost of purchases amounts to $5,354,670, or considerably less than one-third of the cost of maintenance. The expenditure in antiquities, including excavations, has been in Assyria, $90,540; in Ephesus, the large sum of $1,888,165; on manuscripts, $600,160; on music, maps, and books, $1,614,565. These sums do not, of course, represent the intrinsic worth of the collection, as from gifts from private individuals, and also from the fact that all English modern publications are by law obtained free, the true value of the collection is almost incomputable.

IMPROVEMENT OF RIVERSIDE AVENUE.

Department of Public Parks, 36 Union Square, New York.

SPECIFCATIONS. (*Continued from page 326.*)

(*m*). Each pipe shall be subject to all tests ordered by the said Department, and all information required as to the material, place of manufacture, methods of forming, burning, and glazing said pipe, shall be fully given, to the satisfaction of said Department.

How laid. 26. All pipes are to be excavated for and laid true in line and grade throughout, according to the lines and grades furnished from time to time. The ends of the pipes shall abut against each other, and in such a manner that there shall be no shoulder or unevenness of any kind along the bottom half of the Sewers on the inside.

Each joint to be fitted with a collar. (*a*). Each joint, as the pipes are laid, is to be fitted with a collar or ring, which shall lap equally the ends of such abbutting pipe; the lower half of the said collar shall in all cases be whole and unbroken, and the upper half shall not be in more than two pieces; the space between the ring and the pipes is to be as uniform as possible, and to be thoroughly filled with the best hydraulic cement mortar, made of equal parts of cement and clean, sharp sand, thoroughly mixed dry, and water enough afterwards added to give it proper consistency, and in small quantities, and used as soon as made; the joint is to be carefully wiped and pointed inside and out, and all mortar that may be left inside to be thoroughly cleaned out, and the pipe left clean and smooth throughout. When required, strips of pine or spruce plank shall be furnished, six inches wide, one and one-half inches thick, and two feet long, and laid transversely with the trench, one on either side of the joint, and the pipe to rest thereon, and the price paid for foundation plank will be allowed therefor.

Joint to be wiped and pointed.

Foundation strips of plank.

How filled around. (*b*). When the pipes are in place, earth shall be filled in in the manner provided in these specifications. Every third pipe shall be filled around so as to prevent the moving of the joints.

Pipe to be first fitted dry. (*c*). All pipes, previous to their being lowered into the trench, shall be fitted together dry on the surface, and matched, so that, when jointed in the trench, they form a true and smooth line of tubes; and in no case shall they be lowered into the trench until the same is done.

Branch pipe. (*d*). All branch pipe, connections, and pipe of whatsoever kind, shall be excavated for, fitted, and laid as above described.

Hub and spigot pipe. (*e*). When hub and spigot pipe are used, they shall be laid, fitted, and jointed evenly and smoothly, in the same manner as described above.

No walking on pipe. (*f*). No walking on or working over the pipe after they are laid [except as may be necessary in tamping the earth and refilling] will be allowed, until there is at least thirty inches of earth over them.

Pipe to be cleaned as laid. (*g*). The interior of the pipe shall be carefully freed from all dirt, cement and superfluous material of every description, as the work proceeds, for which purpose a disc-mould or plate attached to a rod sufficiently long to pass two joints from the end of the pipe last laid, shall be continuously worked through

Mouth of pipe to be protected. (*h*). The mouth of the pipe shall be carefully protected from all blasts, and the excavation, in all cases, shall be fully completed at least twenty feet in advance of the laying of the pipe; in all cases the mouth of the pipe shall be provided with a board or other stopper, carefully fitted to the pipe, to prevent all earth or other substances from washing in.

Engineer to be present when pipes are laid. (*i*). When the trench is properly prepared for, and before laying the pipe, the Contractor must notify the Engineer, who will thereupon direct an assistant or inspector to be present on the work when the pipes are to be laid; and it is further expressly understood, that at no other time will such laying be proceeded with.

Payment for pipes through wall. 27. Where pipes are required to be laid through the wall, the price per lineal foot bid and paid for furnishing and laying pipe will include all expense of properly laying such pipe, and thoroughly and carefully fitting the masonry around it, so as to prevent settlement or injury.

Brick masonry, quality of bricks. 28. In the construction of brick masonry, none but the best quality of whole North River bricks, burned hard entirely through, will be used; they are to be culled as they are brought upon the ground, and all bats and all bricks of improper quality are to be immediately removed from the work.

Bricks to be wet before laying. (*a*). The bricks are to be thoroughly wet by immersion immediately before laying. Every brick is required to be laid in a full joint of mortar, made as described in these Specifications, on its beds, ends, and sides, at one operation. In no case is mortar to be slushed or grouted in afterwards.

To be laid by line. (*b*). The bricks are to be neatly and truly laid by line, and the joints to be carefully struck on the inside. The bonds in all cases to be formed as shown on the sections.

Fresh work protected. (*c*). All fresh work must be carefully protected from injury in any way. No wheeling or walking on it will be allowed on, and any portion injured must be relaid by the Contractor.

Courses racked back. (*d*). All brick-work, as it progresses, must be racked back in courses, and in no case will it be allowed to be toothed, unless by special permission, in writing from the Engineer.

Mortar, how made 29. All mortar is to be composed of one part of fresh-ground hydraulic cement, of the best quality, and two parts of clean, sharp sand, entirely free from loam. It is to be carefully and thoroughly mixed dry, and a sufficient quantity of water is to be afterwards added to make it of good consistency. The mortar is to be mixed in no greater quantity than is required for the work in hand. Any excess that may be left over at night, or that may have been standing longer than two hours, is not to be re-tempered and used in any way.

No mortar of improper quality will be allowed to be used in the work.

Cement, its quality and test. 30. All cement furnished by the Contractor will be subject to inspection and test before it is used, and if found of improper quality, must be immediately removed from the work.

The Contractor will be required to furnish the Engineer or Inspector full facilities for examining and testing all cement brought upon the ground, and the Engineer is to decide upon the character and severity of the test to be applied.

To be protected from the weather. When cement is accepted, if not immediately used, it must be protected from the weather and kept dry, and in no case will it be allowed to be placed upon the ground without blockings under the barrels.

Mortar box. All mortar must be mixed in a proper box made for the purpose, and in no case upon the pavement or ground.

Both Cement and sand are to be, in all cases, measured in the proportions above required.

Neat cement. When necessary, in the opinion of the Engineer, cement alone, without any admixture of sand, will be used.

Concrete, how made 31. Where concrete is required, it shall be composed of one part of mortar (made in the proportions above described) and two and one-half parts of clean, sharp gravel, or of clean stone, free from dust or dirt, and broken so as to pass in every way through a two-inch ring. It shall be quickly and thoroughly mixed, in a box made for that purpose, and deposited in layers of not less than four nor more than nine inces in thickness, and may be settled into its place by slightly ramming sufficiently to flush the mortar to the surface.

Layers.

No working on it. When in place, all wheeling, working, or walking on or over it must be prevented until it is sufficiently set.

Connections. When connection is to be made with any layer, set or prrtially set, the edge of such layer must be broken down, so as to make the joint fresh and close.

Dirty stone, &c. All gravel and broken stone that is dusty or dirty will be required to be thoroughly screened and washed before it can be used; and such piles or heaps as have any admixture of dirt, stones above the size specified, will be wholly neglected when so delivered upon the work.

Stone masonry. 32. When rubble stone masonry is required, the walls will be of the height and thickness shown on the plan of the work.

Quality and size of stone. The stone used must be of good quality, clean and free from all checks or defects, of good bed and build, and of such general size as may be specified.

How laid. The wall is to be laid true and by line, with the stones on their natural beds, and in full beds of mortar, made as described in these Specifications.

No dressing or tooling is to be done upon any stone after it is in place.

All the joints are to be thoroughly filled with mortar, and the courses properly leveled up.

Bond. A proper alternation of headers and stretchers is to be made, in order to secure thorough bond throughout.

The top of the wall is in no case to be plastered, unless so ordered.

Foundation stone. 33. When required, foundation stones are to be furnished and laid. They must be sound and of good quality, and of such general dimensions as may be specified.

Dry wall. 34. Where dry wall is necessary, it must be well and truly laid, and by line. Every stone must have a fair and even bearing, and the courses be well bonded.

All joints and crevices to be thoroughly pinned and wedged.

The stone must be of the character and quality described in Section 32.

Mason work etc., to cease on the 1st of Dec'mber. 35. Mason work of all kinds shall cease on the first day of December in each year, unless the Department of Public Parks shall otherwise direct, by written notice, and then only for such time as may be therein designated, and no work shall be resumed before the time appointed by said Department; and the same requirements shall hold in the laying and fitting of sewer-pipes of whatever nature, and in the setting curb and gutter, and laying flagging.

Masonry protected. All masonry shall be covered ane protected from frosts by and at the expense of the Contractor, to prevent injury from water or from freezing.

Piles; size length &c. of piles. 36. Wherever Piles are required for foundations, or elsewhere, they shall be furnished of good, sound pine or spruce, free from shakes, They shall not be less than twelve inches diameter at the butts, properly sharpened and shod when required, and shall be driven with a hammer of not less than fifteen hundred pounds in weight, and with a fall not to exceed fifteen feet in height, and driven until the pile shall not yield more than one-half an inch under the blow, unless otherwise directed. The tops to be sawn or cut off truly and evenly to the grade furnished.

Pile shoes (*a*). Cast-iron shoes for piles with a wrought-iron spike, three-fourths inch square, eleven inches long, cast in, weighing twenty pounds, will be used whenever directed.

Sheet piling. (*b*). When Sheet Piling is necessary and intended to remain, it shall be furnished of good pine or spruce plank, of the length, width, and thickness shown on the plan of the work; it shall be sound, free from cracks, shakes, and sapwood, and driven to the depth and in the manner required.

When not otherwise ordered, it is to be drawn. (*c*). The plank shall be tongued and grooved, if necessary, to the width and depth shown. The plank shall be driven with the ram so as not to crack or split. Where sheet piling is rendered necessary, and used only in prosecuting the work, no allowance will be made therefor, and it shall in all cases be drawn as the work progresses, unless otherwise ordered by the said Department, is which case the sheet piling so ordered to be left in the trench will be measured and allowed for at the same rate as foundation plank.

Foundation timber. 37. Foundation timber, of good pine or spruce, shall be furnished and laid where required, all as shown on the plan of the work; the timber shall be sound and free from sap, without cracks or shakes, and squared to the dimensions required throughout its entire length. When placed upon piles it shall be tree-nailed to each pile with good seasoned oak or locust treenails of the length and size shown. Where bolts are required, they shall be furnished of good wrought-iron, headed and sharpened when required, of the size and length shown on said plans, with wrought-iron nuts and washers.

Plank. (*a*). Foundation plank, of good pine or spruce, shall be furnished and laid in the manner shown on the plan of the work; they shall be of the length, width, and thickness there shown, and tree-nailed, as above stated or spiked,

Spikes. as the Engineer may select, to the foundation timbers, with the best quality of wrought-iron nails, or spikes, of the size and length therein specified, and at such points, and in such numbers as may be designated.

(*b*). When it may be necessary to lay foundation boards or plank, they shall be of the kind and quality above described, and cut and laid in the manner designated.

Manholes 38. Brick manholes shall be built at such points as said Department shall direct, of the form thickness, and in the manner shown by plans. The brick-work will be carried up to the grade directed by the Engineer, and from templets correctly made and set at top and bottom, whence not less than eight lines are to be drawn, The work in all respects to be of the quality

Quality of work. required in these Specifications, as heretofore stated for brick-work. The joints to be neatly struck and pointed on the inside.

Foundation. (*a*). The foundations of these manholes will be of stone or brick masonry, or concrete laid in cement, as said Department may direct, commencing not less than twelve inches below the line of the inner bottom of the Sewer at that point.

Steps built in. Wrought-iron rods, of good quality, of the size, length, and shape required for steps, are to be built in where shown on said plan, and the top of manhole to be fitted to receive the iron head and cover, which will be put properly in position as each manhole is finished.

(*b*). The above-described manholes are in all cases to be fully and completely built, and fitted with their covers, as the work progresses, and as each is reached; and the Sewers will not be allowed to be laid down beyond or in advance of any uncompleted manhole.

Inlet basins. 39. Inlet Basins are to be built where shown on plan, or at such other points as shall, during the progress of the work, be directed.

They are to be constructed in accordance with the plans, and with such foundation as shall be directed. They are to be of brick, conforming in all respects to the Specification for brick-masonry. Their foundations are to be of brick, stone, or concrete, as may be directed. They are to be fully and completely built, and fitted with their gratings and frames as the work progresses.

Gratings. 40. Cast-iron frames, with gratings, for inlet basins, and cast-iron frames,

with covers for manholes, are to be provided, in all respects in accordance with the plans. The price per pound for these will include their proper fitting and permanent placing in position.

Basins, etc in stone masonry. 41. Should any basins, inlets, drainage-ways, or other constructions be required to be built in stone, either in connection with the wall or at other points, they will be constructed according to the plans furnished, and as provided in the specifications for stone masonry. This work will be paid for at the price bid for rubble masonry, in cement or dry, as the case may be.

Iron pipe or conduits. 42. Cast-iron pipes or conduits are to be provided and put in place, in all respects, in accordance with plans. The price per pound is to include their proper fitting and permanent placing in position. It is also to include such painting upon them as shall be required.

Quality of iron. 43. All iron, whether wrought or cast, furnished for any part of the work, must be of the best quality, free from all defects in workmanship and from all impurieties.

Sewers, &c., to be kept clean 44. During the progress of the work, and until the full completion thereof the sewers, basins, culverts, and connections are to be kept thoroughly cleaned throughout, and left clean.

Wheelway. 45. The road-beds shall be shaped to the lines and grades directed.

Road-bed (*a*). The road-beds shall then, wherever directed, be rolled with rollers weighing not less than two tons, sufficiently to compact the material to the satisfaction of the Engineer.

Foundation stone. (*b*). The stone for foundation is to be sound and durable quarry stone from seven to ten inches in depth, not to exceed fifteen inches in length, and generally from three to eight inches in width. These stones are to be deposited upon the roadway, and evenly adjusted, so as to form a pavement in which the stones are well and compactly brought together, to the satisfaction of the Engineer.

Foundation surfacing. (*c*). Upon the top of these stones, are to be spread finer rubble and quarry chips, sufficient to fill and smooth over the interstices of the surface; but care must be taken not to fill up the cavities of the lower portion of the rubble-bottom, which must have a cellular character, to facilitate drainage.

With this material is to be intermixed a quantity of gravelly earth or hard pan, to the extent that shall be directed, and the whole being moistened by sprinkling, is to be rolled with rollers of a weight that shall be directed.

The rolling shall be thorough, and continued so as to close all interstices of the surface of the rubble foundation.

Depth of bottoming (*d*). The top surface of the road bottoming described above shall be, when complete, full six inches below the finished road surface, as shown on plans; and provided that the whole depth of said foundation bottoming material be not less than ten inches, the Contractor may, with regard to his own profit, adjust the depth of the foundation stones, and the level of the road-bed, so as to use the quarry stones to the best advantage, always maintaining the required elevation of the surface of said bottoming.

(*e*). In each stage of this work, sufficient labor must be provided to accomplish the specified result to the satisfaction of the Engineer.

Gravel. (*f*). Upon the surface thus prepared is to be spread the first layer of gravel. This shall be sufficient to make a depth of two inches when rolled. It shall be well moistened and rolled.

There shall then be applied a second layer of gravel, also sufficient to make a depth of two inches when rolled. This layer shall also be well moistened and rolled.

The gravel for the two layers above described shall be clean and free from loam and dirt. The particles of which it is composed shall be of sound, hard and durable stone, and it must, in all respects, be approved by the Engineer before being used.

The rolling of both layers shall be done with rollers of a weight to be approved, and to the extent that shall be directed.

(*g*). The top layer of gravel shall then be applied, which shall be in depth sufficient to bring the finished surface of the roadway to the final lines and grades. The depth when finished of this top layer of gravel shall not be less than two inches.

This top layer of gravel shall be of the sort known as "Roa Hook" gravel, or of a quality equal to that gravel in strength and other characteristics.

It is to be thoroughly rolled until the surface of the roadway becomes smooth and compact.

All the gravel used for the drive shall be composed of stones, generally measuring from one to one and one-half inches in diameter, with only such admixture of finer particles as shall be approved.

Sprinkling. (*h*). During the progress of rolling, the road shall be kept well moistened by the use of sprinkling carts or wagons, the amount of water to be applied being as shall be in each case or stage of the process directed.

Rolling. (*i*). Each of the strata of the pavement is to be rolled until, in the opinion of the Engineer, it is properly complete.

The rollers shall be of a construction and weight approved by the Engineer.

(*j*). If directed by the Engineer, at any point, an addition to the top layer of gravel shall be made of stone screenings or other suitable material, approved by him, in quantity sufficient to compact and properly consolidate the surface.

Pavement of ride. 47. The road-bed shall be brought to the sub-grade directed, which shall be fifteen inches below final surface.

(*a*). It shall then, if so directed, be rolled with rollers, as specified for carriageway, sufficiently to compact the material to the satisfaction of the Engineer.

Foundation material. (*b*). There shall be deposited thereon gravelly or sandy loam, approved by the Engineer, in such quantity as to bring the surface within six inches of finished grade. This shall then be rolled so as to compact its surface, as shall be directed.

Gravel for ride. (*c*). Upon this shall be placed gravel, sufficient to bring the ride to the established grades and lines.

This gravel shall be of a quality to be approved by the Engineer, and shall be screened from all stones measuring more than one half of one inch in any direction.

This gravel shall then be rolled lightly, but sufficiently to compact it moderately, and to bring its surface to the established grades and lines.

Pavement of walks. 48. The walk surfaces are to be brought to the sub-grades and lines directed, and, if required, are to be rolled till well compacted, to the satisfaction of the Engineer.

Foundation stone. (*a*). Quarry stones are then to be filled in to the depth of six inches, placing the smallest on top. These stones are to be so placed as to lie well together; upon their surface is to be put a layer of finer quarry chips or other approved material, which is to be sufficiently compacted to prevent the gravel from running through to the loose stone below.

(*b*). This surface is to be sprinkled and rolled.

Gravel. (*c*). Gravel two inches in depth is then to be spread, sprinkled and rolled sufficiently to secure a good surface, to the satisfaction of the Engineer.

The gravel used must be fine, the particles generally not exceeding one-half of one inch in any direction. In spreading the gravel, the larger stones are to be kept to the bottom, by raking them forward.

Sufficient labor must be provided to accomplish this result satisfactorily.

The gravel used for walks must be the same, except as to size of particles, as that hereinbefore specified for the top layer of wheelway of drive.

General description of gravel. 49. All the gravel used, whether for drives, roads, rides, or walks must be clean and entirely free from loam or dirt. The particles of which it is composed must be of sound, hard, durable stone. Its color must be satisfactory to the Engineer. Samples of the gravel proposed to be used, must be submitted to, and approved by, the Engineer, before delivery upon the work.

Prices to be for full completion. 50. The price bid for pavement of either drives, roads, rides, or walks will be in full, in each case, for fusnishing all stone, gravel, and other materials and implements, and all labor requisite to fully comply with these Specifications, and to complete the pavements in every respect.

Gutters. 51. Where so required, gutters shall be laid of quarry stone of gneiss, trap, or granite. These stones are to be from eight to twelve inches deep, from three to five inches wide, and not less than eight inches long. They are to be roughly shaped, sufficiently to fit compactly together. They are to be bedded upon a well rammed layer of gravel, sand, fine quarry chips or coal ashes, not less than one foot in depth. They are to be laid by hand, truly and evenly, and rammed to a firm bed, so that their surface shall conform to the lines and curves directed. All interstices are to be filled with fine stone chips, sand or gravel.

(*a*). The price bid for gutters, will be in full for furnishing all materials and labor, and laying, ramming, and finishing the gutters.

Granite curb. 52. These are to be of sound and durable granite, of a color and quality to be approved by the Engineer. They are to be seven inches in width on top, and of uniform depth, not less than twenty inches. They are to be in length, not less than five feet, except where special lengths are ordered, in which case, the lengths are to be as ordered. The stones are to be straight lined, without wind, and to be free from bunches or depressions. They are to be peen-hammered on top, and three inches down on back. The front to be cut smooth, and to a fair line, and with no projections or depressions exceeding one-half inch from the working lines, to a depth of twelve inches down from top; the rest of the front and the back of the stones to be pointed off roughly, but the stones to be in no case less than seven inches in thickness. The ends to be squared and jointed to the full depth of the stone, so that when laid, they shall make joints, not to exceed three-eighths of one inch.

Granite curb angle stones. 53. At the ends of tree-plots, and at such other points as shall be directed, the granite curb will be provided and set in special length, with joints cut to the angles shown on plan, and with faces dressed as directed.

Except as to the lengths, the angles at joints and the face dressing, these special angle-stones are to conform to the specifications herein made for granite curb. These angle-stones will be measured upon the longest top edge.

Blue stone curb. 54. These are to be sound and durable, of the best quality of blue stone. They are to be in lengths of not less than three feet, except where special lengths are ordered, to be five inches in thickness for the full depth of the stone and twenty inches in depth for the entire length of the stone. The top of the stone to be cut either to a bevel of one inch or square with the front, or to such other bevel as may in each case be directed, and to have sharp and perfect edges, both front and back; the front to be cut smooth and to a fair line, without winding, and with no projection or depression exceeding one-half inch from the working line, to a depth of twelve inches from the top. The bottom to be roughed off parallel to the top to the full thickness of the stone.

The ends from top to bottom to be truly squared and dressed, so that when laid they shall make joints not exceeding three-eighths of one inch.

Blue stone edgings. 55. These are to be of the best quality of blue stone, sound and durable. They are to be in lengths of not less than three feet, except where special lengths are ordered, to be two inches in thickness for the full depth of the stone, and twenty inches in depth for the entire length of the stone. The top of the stone is to be cut smoothly, without bevel, and must have sharp and perfect edges, both front and back. The front to be cut smooth, and to a fair line, without winding, and with no depressions or projections exceeding one-half inch from the working line to a depth of two inches from the top. The bottom to be roughed off parallel to the top for the full uhickness and length of the stone. The ends from top to bottom to be truly squared and dressed, so that when laid they shall make joints not exceeding three-eighths of one inch.

Blue stone edging of special forms. 56. Should blue stone edging be required, with ends not squared to the top, and of special form, they shall be furnished and laid in accordance with plans and directions. Except as shown by such plans and directions, they shall conform in all respects to the specifications for blue stone edging, as herein made.

Circular corners. 57. The corner curbs to be in lengths, as directed, to be dressed to the curve that shall in each case be directed, to be of the same thickness at joint as provided for the straight curb, and to be straight on the back. In all other respects to be dressed as specified for straight curb, and to be of the quality specified therefor. The length to be paid for shall be that measured on the curved top edge of each stone.

Method of setting curb and edging. 58. All the curb and edging stones to be laid truly to the lines and grades given, with joints not exceeding three-eighths of one inch, to be back-filled and backed up with at least one foot of clean sandy material, or clean coal ashes, free from clay or loam, and well rammed.

All the stone to be set so as to show the front to the depth in each case directed. Where there are curbs meeting other curbs, the points of junction shall be set with joints not exceeding there-eighths of one inch, and the stones shall be cut to the lines and angles in each case directed.

Price to include all requisite work. 59. The price bid for curb or edging stones will be in full for furnishing all the materials and labor requisite to permanently set the stones in place, including excavation of trenches, back-filling, and fitting, and all work necessary fully to comply with these Specifications.

Flagging. 60. The flagging to be of the best quality of blue stone, free from cracks or shakes, to be not less than two feet in length, and of an uniform width of four feet, and to be in no place less than two and one-half inches thick; to be smooth and even on the upper surface, the sides to be dressed clear of drill or chisel holes, and square with the upper suiface for at least one inch down. The joints to be dressed so as to make joints not exceeding one-half of one inch. The corners to be square.

The stone to be bedded in four inches of clean, gritty earth, or clean coal ashes, free from clay or loam.

The stone to be laid truly to lines and grades given, with close joints, not exceeding half an inch, with a true and even surface, the joints to be closed up with wet earth, and left clean on the surface.

(*To be Continued.*)

Water Works, Ancient and Modern.*

BY E. H. D'AVIGDOR.

(*Continued from page* 328.)

The *third* method lies between the two others. It is the favorite and well-known English plan (also adopted in the South of France), of closing a valley by an embankment, thus forming an artificial lake, and storing the water for future use. From this point a main, conduit, or aqueduct carries the water to a distributing reservoir in the same way as in the case of springs. This system has some decided advantages. It is based on the correct principle on which Belgrand and other writers on sanitary subjects have laid much stress, that there must always be too much water for there to be enough. This principle does not imply that waste is necessary; it only expresses in a few words that there should always be a very large margin of supply over and above all calculations based on averages to provide for droughts, fires, flushing the sewers during epidemics, and other contingencies. I need hardly say that, by the English system, all the water falling on a certain area is employed for useful purposes, except the portion which necessarily evaporates or percolates into the ground. The supply, therefore, no longer depends on one single spring, but on the rainfall over a more or less extensive district, and an immense reserve being established, the water supply to the city can be kept up regularly even during periods of prolonged drought. The reservoirs are therefore constructed with a capacity of from 150 to 250 days supply, and the embankments attain an immense height. Thus, the bank of Yarrow reservoir is 80 ft. high, and many others exceed these dimensions. The well-known Dale Dyke Dam, near Sheffield, which burst on the 11th of March, 1864, was 95 ft. in height. This accident has caused the English principles of embankment to be entirely neglected on the greater part of the Continent; yet the many causes which contributed to it are sufficiently well known to prove that all fears for the safety of a well-constructed dam are perfectly groundless. No doubt the puddle core of the bank was originally too weak; then the bank itself was not brought up in stamped layers, but partly tipped; the ground all about was liable to landslips, and the fact of the discharge pipes being laid *through* the embankment caused unequal settlement. All these causes can be avoided by careful design and execution, and no English engineer would dream of abandoning the sound principle of collecting the water of drainage areas on account of this accident or the one at Bradford. The precautions now adopted are, firstly, to carry the puddle by a deep trench down to a completely impermeable stratum; to increase the thickness of the puddle itself; to bring up the bank in carefully stamped layers, slightly inclining towards the centre; to lay the discharge pipes in a cutting or tunnel round the end of the bank instead of through it; finally, to provide a bye-wash, so that in case of repairs the water descending from the drainage area may be at once turned into the waste weir, instead of filling the reservoirs.

One of the finest applications of the system of catch-water reservoirs is exemplified in the works barely completed for the supply of Liverpool. Here the drainage area is 10,000 acres, and the total area of the seven magnificent reservoirs constructed is no less than 610 acres, containing 4,268 million gallons. This gigantic undertaking which has provided Liverpool with a water supply second to none in the kingdom, and has had a most beneficial effect on the bills of mortality, should be a sufficient and satisfactory proof of the perfect safety with which the system can be adopted if ordinary precautions are used. And although it is fortunately not necessary for the Austrian towns south of the Danube, where the snowy Alps with their glaciers supply a sufficient number of pure springs, I have no doubt it might frequently be applied with advantage in the undulating portions of Germany proper, and even in the hills of Bohemia and Moravia. There appears to have been so much difficulty in finding sufficiently reliable springs for the water supply of many German towns, and the advocates of river water, which is liable to pollution, have so often gained the upper hand in consequence, that I cannot sufficiently recommend the English system to German engineers as being one in many cases thoroughly applicable to their country. Nor is it used in England alone. The justly celebrated reservoir of the Furens, near St. Etienne in France, is closed by a masonry dam no less than 162 ft. in height, which serves the double purpose of collecting a water supply for the town, and of moderating the violent floods of the mountain torrent on which it is placed. If my German colleagues therefore are afraid of earthen embankments, let them construct masonry dams like those of St. Etienne and St. Chamond.

The method of bringing the water into the town from the reservoirs, lakes, or springs is different in England to that used on the Continent. A small length only of the Liverpool and Glasgow mains consists of tunnels in which the water runs without the intervention of pipes. In France and the largest cities of the Continent masonry conduits and aqueducts are preferred; in England, on the contrary, cast-iron pipes are invariably used. This is of course a mere question of economy. In many parts of the Continent cast-iron is comparatively dear; there are no skilled pipe-layers at hand, and the carriage of pipes over rough country roads in remote valleys is expensive and dangerous. On the other hand, both materials and workmanship for masonry are generally cheaper than in England, rough stone is plentiful, and good hydraulic limes are now produced almost everywhere. It is therefore natural that when the dimensions which would be necessary for pipes are considerable, an aqueduct of masonry is preferred; the limit at which the cost of the two is equal varies very much according to the locality, the facilities of transport, and the materials and labor available; no fixed rule can therefore be given, but it may be stated, subject to correction, that under 24 in. diameter pipes are almost always cheaper than masonry conduits. I find the limit at Vienna to have been about 33 in., *i. e.*, had the quantity of water not exceeded that passing through a 33-in. pipe at the given gradients it would have been cheaper to lay pipes. But as it is, the water would have required 36-in. to 39-in. pipes, and an aqueduct was therefore preferred; the question of crossing the valleys by inverted siphons being of course quite another matter independent of this, and varying enormously, according to the depth and width of the valley to be crossed.

We have now reached a point at which it will be convenient to describe the two most important water works of modern times obtaining their supply from springs—I mean those of Paris and Vienna. I have purposely omitted mentioning the great and important works executed in the United States of North America, where the English principle of catch-water reservoirs is mostly applied. I have also said nothing about the distribution of water. To have described the American works would have merely increased examples and lengthened my papers; to discuss the subject of the distribution of water with the fullness it deserves would have implied a second series of lectures. I leave this to abler pens, and at once take up the supply of water to Paris where I left it, namely, at the end of last century. I described the deficiency of the quantity supplied up to that period. It was only 70 years ago under the first Empire that serious steps were taken to remove it. The Canal de l' Ourcq was completed in 1809. It is 96 kilometres (about 60 English miles) long, and obtains its supply from the two small streams the Ourcq and Benvroune, which it brings down in an open channel to the collecting reservoir at La Villette. By means of this canal Paris was supplied with 2½ million gallons of drinking water daily. But the government and muncipality had the unfortunate notion of constructing the cut wide enough to use it as a navigable canal, intending thus to kill two birds with one stone. The water was therefore exposed to every possible pollution, and has gone on from bad to worse with the increase of the traffic on the canal, and the addition of the water from the river Marne, which conveys a very large portion of the boats trading to Paris. This increased the supply to above 20 million gallons daily, but did not improve its quality. Notwithstanding these drawbacks the water rates began to pay from the very day of the opening of the Ourcq Canal. From the ridiculous sum of 385 francs in 1800 they rose to 229,833 francs in 1810, and have increased rapidly ever since. Up to a very late period the pumping engines (which had been repeatedly renewed and enlarged), the two little aqueducts of the Northern Springs and of Arcueil, and, lastly, the Canal de l'Ourcq, were the only sources of the Parisian water supply; the total quantity distributed was only about 38 million gallons daily, and the quality was much worse than the quantity. The discovery and introduction of better water for drinking and household purposes were urgent, and from 1864 to 1867 M. Belgrand, the able chief engineer of the drainage, sewage, and water supply of Paris, commenced the construction of two great spring-water aqueducts. The springs chosen were those of the Dhuis in the department of the Aisne, and those of the Vanne, near Sens, in the department of the Yonne. It was originally intended to collect the water of the Somme-Sonde as well, but this plan had to be abandoned, as the proprietors of the land through which the line passed brought forward such enormous claims and raised so many difficulties, that the purchase of the ground necessary would have far exceeded the estimate.

I have more than once mentioned the favorable position of Vienna with regard to water supply. The study of the prolonged researches made by the French engineers within a radius of 100 miles of Paris, to discover a set of springs at all equal to the demands made upon them, confirms this opinion. Paris is surrounded on every side by fertile plains and low hills; the forests are limited to those belonging to the State, every square yard of ground is made to yield its utmost by the small holders, there are no mountains, moors, lakes, or glaciers able to store a supply of water. We can therefore, hardly be surprised that the French engineers were unable to arrive at a perfect solution of the question of their water supply; they did all they could within the limits assigned by nature.

The springs of the Dhuis and those of the Surmelin supply pure water of 18 deg. of hardness (French graduation) equal to about 11 German. The level of the springs is 128.5 metres above the sea, that of the reservoirs at Menilmontant 107.85. The total fall of the aqueduct, which is 134 kilometres long, is therefore only 20.63 metres. But this fall is not equally distributed over it; the 118 kilometres of natural fall have a gradient of 1 in 10,000, while the remainder, which consists of inverted syphons (pipes under pressure), has a gradient of 0.55 per 1,000. The cross section is egg-shaped 1.10×0.70, the masonry of ashlar being only 20 centimetres or about 8 in. thick, and the whole section is coated by a layer of Portland cement 2 centimetres (4-5 in. thick). The entrados of the arch is similarly covered down to the springing. The level of the water was estimated at 30 centimetres (1 ft.) below the keystone; this would have been equal to a flow of 40,000 cubic metres, or about 8,800,000 gallons daily. But in fact the supply obtained hardly exceeds 25,000 cubic metres, or 5,500,000 gallons. The total length of the tunnels is 9 7-10 kilometres, and at the commencement of each there is an overflow carrying the waste water into the nearest valley. The same precaution is adopted at the upper ends of all the inverted syphons. The latter consist of cast iron faucet and spigot pipes 1 metre (39.1 in.) diameter, and 21 to 25 centimetres (4-5 in. to 1 in.) thickness according to the pressure; this exceeds the thickness adopted in Vienna by 30 per cent.

The Dhuis water runs into the reservoir at Menilmontant, which is constructed in the grey marl of the hill of the same name. It has a capacity of 22,000,000 gallons, besides a basement used for storing the Marne water, and capable of containing 6,500,000 gallons more. The plan of this reservoir is a large semicircle of 188 metres diameter, joined to a rectangle 188 metres by 42. In order to facilitate repairs it is divided into four parts by cross walls which communicate at their intersection with a tower containing four flights of steps, one for each compartment. The retaining walls are 1.90 m. (about 6 ft.) thick; the reservoir being covered by cross vaults resting on 620 piers, each 0.60 m. or 2 ft. square. The vaults are 5.40 m. span, and only 0.90 m. or 1-9 rise, the arches being constructed of two rings of brick together 0.28 m. thick. This very bold construction has been justified by the result, and the absence of cracks or settlement is to be attributed to the excellence of the materials used, and to the immense care and minute supervision exercised during construction. The vaults are covered by a layer of earth 0.70 m. thick over the crown, and the whole of the interior is lined with a coat of Portland cement 1 in. in thickness; the maximum level of the water being at a level of 5 metres above the floor.

The Dhuis aqueduct cost, exclusive of purchase of ground and springs, 12 6-10 million francs (£464,000), the reservoir 3,500,000 francs (£140,000).

(*To be continued.*)

* A course of papers delivered at the Austrian Institution of Engineers and Architects, December, 1875, and January, 1876

REPORT ON THE MISSISSIPPI JETTIES.

BY JAMES B. EADS, CHIEF ENGINEER.

We have received this report, dated New York Aug. 18, and addressed to J. S. Walsh, President, South Pass Jetty Co., St. Louis.

It contains statements in regard to the condition and progress of the work up to that date, which it is unnecessary to repeat here, as we have given much later information from the map of Sept. 12 and 13, transmitted to us by Mr. Corthell. This really constitutes a very small part of the report which is evidently a controversial document, written in order to dispel doubts and to eradicate certain notions or hypotheses which may have taken root in the public mind, from reading the reports of Maj. Comstock of June 9, and also literature emanating from the Government engineers and other sources, unfavorable to the jetty project. This, however, is not stated in so many words.

He alludes at considerable length to the results arrived at from the survey on radial lines by Lieut. Marinden, and gives as the reason of the lateness of this report, "the delay in obtaining an official statement of the result of soundings made in front of the jetties about three months ago." His letter to the Superintendent of the Coast Survey requesting the survey, is printed in full and also the reply of the superintendent to a letter of July 19, from the Secretary of War, requesting—"a statement setting forth what amount of shoaling or deposit has occurred since the survey made by you last year in advance of the jetties; or what amount of deepening, if any, with the view of determining what amount of advance has been made at the time of your last survey of the South Pass bar in front of the jetties since their construction."

In this letter, referring to the request of Capt. Eads for a survey, the superintendent states:—"With my consent the observer was occupied on two days, April 29, and May 15, 1876, but was recalled in consideration of the general impropriety of permitting continuous work, not only without authority of law, but in seeming rivalry with the officers of the engineers who have been detailed by the Hon. Secretary of War for inspecting the progress and quality of the constructions and the effect of the projected improvement of the South Pass." He calls this "the partial examination of 1876," as contrasted with "the careful survey of 1875," previous to Mr. Eads' operations and says it was "merely incidental, and not projected for comparison with the first survey, nor sufficient for that purpose." After giving many figures and discussing the tracings accompanying the letter, the superintendent says (in regard to a certain area, 800×900'yds., in front of the jetties)—"The deposits * * * * * amount approximately to 311,300 cubic yards, and the scouring to 379,700 cubic yards, a difference of 68,400 cubic yards, equal to a space 410 by 41 yards, and 4 yards deep." Capt. Eads says:—"By taking in the outer slope of the bar * * * * excluded from Mr. Patterson's estimate" this would be increased to 150,000 cubic yards. In a letter from Max E. Schmidt of June 5, in an area of "51.7 acres beyond the old crust of the bar in May, 1875" there is a "gain of 206,425 cubic yards of water." Supt. Patte son also states that the contents of "the shoal above 18 feet," (low water) "had decreased about one half." In discussing the letters Capt. Eads, referring to the surveys of Lieut. Marinden, and the paragraph of the superintendent's letter previously quoted, says:—"Unless made" (the surveys) "for such comparison, it would have been without any object whatever, and would not fulfill the purpose he had in view." Leaving this controversial point, he enlarges at considerable length on the deepening in front of the jetties and the wearing away of the shoal or mud-lump, clinching his remarks thus: "I have differed on this question, I believe, from all engineers who have expressed views upon the subject.. I have constantly maintained the more extreme opinion that the necessity for extending the jetties after a depth of thirty feet shall have been secured by them, will not occur for many centuries. The present deepening in advance of them strengthens my belief upon this point."

He speaks at some length of the works at the head of South Pass. At this point a depth of 16 feet at mean high tide existed at the commencement of the work. "The original plan of improvement contemplates the closure of Grand Bayou," situated midway of the pass and discharging about 23 per cent. of its volume. "Its closure would consequently add about 30 per cent. to the water passing out through the jetties by which the current below this outlet would be largely increased, while the current in the pass above would be proportionally retarded, until the channel below the outlet should sufficiently enlarge to restore the normal velocity. Enlargement and deepening were consequently to be anticipated below, while shoaling would be the result naturally expected above."

"The head of the pass is divided by an island into two inlets of nearly equal magnitude, and the original plan of improvement contemplated the ultimate closure of one of these. It was believed that if Grand Bayou and one of these inlets were closed simultaneously, the expected shoaling above the pass would not occur, because, although the volume entering the pass would be temporarily lessened by the dam at Grand Bayou, the size of the entrance into the pass would be reduced in a greater ratio by the closure of one of these inlets, and the retardation of current across the shoal above the other inlet would be prevented, It was, therefore, determined to close the inlet and bayou at the same time." This was prevented, and to this delay is ascribed the subsequent shoaling to 14 feet at the head of the pass.

Farther on he says: "It has been asserted in some of the public journals, that the construction of the works necessary to contract the flow and deepen the obstructions, must have the effect of permanently lessening the quantity of water which enters South Pass at the time our works were commenced, and would, therefore, cause a permanent reduction in the size of the pass." This, he says, is disproved by repeated measurements of the pass itself.

In another place he states that "Pass a Loutre was contracted 600 feet in width by one of our dykes," the effect of which "was to *raise* the suface of the water *above* our works, while *below* them the reduced supply caused the surface to be *lowered*." A greatly increased velocity of current resulted, inducing rapid scouring by which the size of the pass "was entirely restored by an equivalent amount of deepening." While this deepening was progressing, an increased quantity of water was thrown into the other passes which must have resulted in permanent enlargement of channel, which, experience at the jetties, has shown "begins at the upper end and advances down stream;" had it not been that "before this enlargement of South Pass and Southwest Pass could extend any great distance down, the recovery by Pass a Loutre of its full section was accomplished, and the temporarily disturbed equlibrium of the three passes was restored."

The remarks in regard to South Pass are so interesting that we give them in full:

The flow into this pass will unquestionably be temporarily lessened, and the excess will be temporarily thrown into the other passes. An enlargement of the upper ends of these passes must at once commence, but at the same time the contracted entrance into South Pass must, from the same cause, commence also to enlarge, and in proportion as the enlargement of the latter progresses, the head of water temporarily raised by the works must be lowered, and the extra flow into the other two passes must be diminished and finally cease altogether. In other words, while the river will have only half a mile in length of enlargement to make at the head of South Pass, to recover its equilibrium, it must enlarge Southwest Pass through its entire length of seventeen miles before any permanent alteration in the respective volumes flowing through the two passes can take place. While the removal of the shoal is progressing, a considerable portion of it will be found deposited in the deep water immediately below it, where no contraction has occurred, and where the first reduction of velocity will be felt, and from whence it will be gradually removed as the enlargement above restores the velocity below.

We take the liberty to say that we cannot follow Mr. Eads' reasoning in regard to this point. We can see how the enlargement of a pass should take place at the place at which the increment of velocity occurs, the stream becoming saturated with detritus and refusing to scour farther at that velocity, the enlargement thus advancing down stream; but we cannot see why a pass should necessarily enlarge throughout its entire length before any permanent alteration of its volume can take place. It appears to us that, with the same head, a pipe line composed of two different sized pipes would carry a greater volume in a given time than a line exclusively of the smaller section. Hence we should expect a greater volume to flow through Southwest Pass even though its enlargement was not complete throughout. There are two or three other points of theory put forth which we fail to comprehend exactly, but we believe they are not so material, and the large space devoted to the jetty question this week postpones them for future consideration.

The report farther contains the essential part of the "Grant from the United States, authorizing the construction of the Jetties," which we shall publsh at a future time with such comments as may seem warranted.

Accompanying the report are some charts which are very interesting and valuable for future reference.

THE NEW THAMES SUBWAY.

A third tunnel is to be built under the Thames, this time between North and South Woolwich, a Parliamentary act having been passed for that purpose in 1874, owing to the danger and inconvenience of the river passage at that point.

Commencing on the north bank near the Great Eastern Railway station, a shaft 24 ft. in diameter will be sunk to a depth of 26 ft. from the bottom of which the subway will commence, having a descending gradient of 1 in 8 for 444 ft., at which point the footway will be 74 ft. below Trinity high-water mark, thence rising 1 in 140 for 860 ft., and then 1 in 8 for 489 ft. to a point 20 ft. below surface of ground at Bell Water-gate, South Woolwich, terminating in a shaft similar to the one on the north shore, the total distance between these shafts being 1,793 ft.

The tunnel will be formed of cast-iron segment rings three feet in length and nine feet internal diameter, these rings being bolted together by internal flanges, the pannels formed by the horizontal and vertical joints being filled in with white glazed brick, in order to reflect the gas-light. The floor will be 7 ft. wide, of ashphalt laid on a bed of concrete. Ventilation will be effected by means of a perforated tube along the top of the arch.

Judged from the borings a gravel formation will be met on the north side and a chalk formation on the south side, the geological maps showing a probable fault beneath the river at which the subway will pass from the water-bearing gravel to the chalk.

For the purpose of excavating this loose strata the contractor has devised the following method: A shield or cap lapping over and enclosing the advanced end of the tube, is pushed ahead by hydraulic rams belting against the completed tunnel. Through several openings in the face or end of this shield a powerful jet of water is forced by means of a rotary pump, excavating the material, which with the water is led back through a pipe attached to a large opening at the bottom of the shield, into a tank at the rear from which the water is again repumped, thus keeping up a constant circulation. The debris is removed from the bottom of this tank through suitable valves. To assist in the disintergration of the soil long rods or chisels are worked through a sort of ball and socket stuffing-box in the face of the shield.

In the case of boulders other obstructions or injurious soil being met, the shield is so constructed as to admit of the attachment of an air-lock and working-chamber, the water being held back by compressed air. As the excavation advances the shield is constantly forced up to its works by the hydraulic rams, dragging after it the tank and the whole machinery, which will travel upon rails laid for the purpose. The segments of tunnel will be swung into place by a mechanical appliance which travels with the other machinery.

The estimated cost is £75,000. The toll to be taken under the arch is 1 ct. Weekly tickets will be issued at reduced rates. At the present time 8,000 workmen cross and recross from North to South Woolwich daily, and it will undoubtedly be used by many others. The novelty of construction proposed has excited considerable interest, It is similar in its use of compressed air, in some respects, to the method to be used in the Hudson River Railway tunnel, to connect Jersey City and New York.

WE call attention this week to the valuable thoughts of Col. W. Milnor Roberts, formerly a member of the Jetty Commission, in regard to the question of bar advance and the future necessity of extending the jetties. Col. Roberts, along with General Barnard, is known as an able advocate of the jetty system as applied to the mouth of the Mississippi.

The Krupp Iron Works.

It may interest our readers to know that these works, located at Essen, Rhenish-Prussia, employ in the steel foundries 10,500 men, and in the mines and forges 5,000. In the steel factory there are 1,648 furnaces of various kinds in full blast, 208 steam boilers, 77 steam hammers, 294 steam engines of from one to two thousand horse-power, and 1,093 other machines. In the year 1875 the manufactory consumed 612,000 tons of coal, 4,500,000 cubic metres of water, 7,500,000 cubic metres of gas, supplying 22,422 burners. The means of transport and communication comprise 25 miles of railway, with 14 engines and 537 trucks; 11 miles of narrow-gauge rails, with 10 engines, 210 trucks, 80 horses, and 214 wagons, and 38 miles of telegraphic wires. The mining department sees to the working of the 414 shafts which are being worked in Germany, exclusive of those belonging to the Krupp Company in the North of Spain, the minerals from which latter place are conveyed in four steamers with a total tonnage of 1,700 tons. The practice-ground for the guns made at Essen is at Dulmen, and it is nearly five miles long.

THE New Orleans papers of October 13 contained a communication from the Bar and River pilots addressed to the Cotton Exchange, Merchants' Exchange, Board of underwriters, Chamber of Commerce and others, which was posted on the boards of the Cotton Exchange. It set forth "that the material being dredged from the bar at the head of the South Pass is being deposited at the head of Southwest Pass; also that the jetty as being constructed partially closes the Southwest pass at its head in such position that, especially during foggy weather, it will form a dangerous obstruction to the passage of vessels into Southwest Pass. We fear that these works will seriously impair the navigation to Southwest Pass, as, since the commencement, the channel across the outer bar has already shoaled six inches." Probably no action will be taken by the boards, as they evidently appreciate the necessity of allowing full scope to the works at the head of the passes, and will be willing to suffer any temporary inconveniences in the hope of the successful prosecution of the works. If the Southwest Pass bar has shoaled six inches, due to a decreased volume of water, etc., it is a hopeful sign that the river is at present under control, and that the works at the head of South Pass are giving it an additional water supply which it probably very much needs.

THE New York *Graphic* illustrates what its correspondent calls one of the most interesting novelties of the Philadelphia exhibition, viz., a model of a compressed air locomotive, constructed by the under-graduates of the Polytechnic school of Philadelphia, which, from the description, is very creditable to them. A large boiler-shaped chamber, mounted on trucks, contains the compressed air, which is supplied from a larger reservoir at the foot of the incline, where it is compressed by any ordinary form of air compressor. A small air pipe extends along the incline, with air stations at intervals to supply the chamber should the pressure fall below the working pressure. The cylinders work horizontal gripping wheels, which run against an edge-rail placed in the centre of the track, the pressure against this rail being regulated to the traction required. These gripping wheels also serve the purpose of breaks. However, we believe the system of horizonal gripping wheels was long ago applied to one of the inclined railways of the Alps, although our memory does not now recall the place or the name of the inventor.

SECRETARY FISH, in his desire to make the Nicaraguan Ship-Canal question an international one, has succeeded beyond his expectations, having received general recognition of its importance, and hearty assurance of co-operation from all the great maritime powers. Nicaragua, herself, has failed to respond, although nearly a year has passed since the proposition was addressed to her, she evidently not fully realizing or being indifferent to results of so much importance to herself. It is believed by Secretary Fish that a renewal of the proposition will meet with the favor of that government, said government not fully appreciating the importance of immediate action.

THE West Side Pumping Works (Chicago) were set in operation on Monday, and the duty test will be made in a few days. The engines were designed for a capacity of 30,000,000 gallons per twenty-four hours, and a duty of 90,000,000 as per specifications. This is, we believe, the highest duty yet contracted for in engines of this character, and considerable interest is felt in the result of the duty test. There is no apparent reason why they should not exceed the duty of the famous Lynn engines, viz., 104,000,000. Indeed, the advantage of capacity, size of cylinders, refinement of valve movement, previous experience, etc., is much in their favor We hope soon to give a description of these, the largest and finest water-works engines yet constructed in this country, along with the results of the duty test, etc.

REPORTS have been received in England that the expedition which went out last spring, under Mr. McKenzie, for the purpose of surveying the bed of the proposed inland sea of the Sahara, has been broken up, having failed to accomplish the result set out for. This is said to result from internal dissensions in the company, and from inadequate provision for the work. Several depressions were found in the coast, but of any of these no reliable survey seems to have been made, or any definite result arrived at. This may prove differently, however, on further information.

IN cleaning out our work-shop we have come across a controversial article by Ch. J. Quetil, C. E. published in the *Railway World* of Aug. 29, in reply to an article that appeared in the *Railway Gazette* the week previous. It is entitled "The Relative Cost of Broad and Narrow Gauge Railroads," and endeavors to show Mr. Forney that cars of same capacity cannot be built as light on broad-gauge as on narrow-gauge roads, and that such cars, if built, could not avoid the necessity of transhipment, as they would not be of a character to couple in trains with standard stock, Of the details of the argument we have not space at present to give an intelligible abstract, and shall have to defer it to a more favorable opportunity.

———For a similar reason we are obliged to defer for the present the publication of a paper read at the September meeting of the Engineers' Club of the Northwest, entitled, "Transportation Routes to the Seaboard," by John E. Thomes, C. E., which is an interesting resume of the various projects and surveys growing out of the report of the Senate Committee of 1873-4.

The Centennial Exhibition.

BY C. J. MOORE, C. E.

[Written for Engineering News]

As is generally well-known, engineers are well represented at the Exhibition, both by the Societies' and individuals' exhibits, and the West Gallery, Main Building, in which are exhibited the various engineering matters collected by the American Society of Civil Engineers, is the regular resort of all engineers, both civil and mining, American and foreign. Besides this there are the rooms of the American Institute of Mining Engineers, at 1100 Girard St., at which there are many maps and plans interesting to those whose duties or inclinations comprise mining matters.

Every Thursday evening at these latter rooms there is an informal meeting of engineers of all branches of the profession and frequently of all nationalities; "Every one is welcome," and in the informal papers which are read and the talks with engineers there is frequently much that is of great interest. On the 5th inst. Prof. W. P. Blake spoke extemporaneously upon the Franklinite deposits of Northern New Jersey, and illustrated his remarks by sketches on the blackboard. He briefly sketched the history of the developments of the ores and the first efforts made to work it for the iron; its early investigation by Russian metallurgists who reported unfavorably as to the extent of the deposits. At that time only *one* mine was opened and that only for a short distance below the surface; since then the mine has been carried much deeper, proving very extensive deposits at present depths, and the hill at the opposite side of the valley has also been explored and is now being mined with very satisfactory results both as to quantity and quality.

The ore, as is well known, is worked chiefly into American Spiegel pig, for use in the Bessemer process, but it is also worked for zinc oxide, which when ground makes a very durable and cheap pigment. Prof. Blake, with several other interesting remarks upon the character of these oxides, brought his statements to a close.

Last night Col. W. Milnor Roberts read a paper upon "Engineering Thought and the Centennial," in the midst of which, after referring the origin of all forces to the force of gravitation in some form or other, the lecturer proceeded to illustrate by reference to the Mississippi River and the jetties now in process of construction by Capt. Eads, as an example of gravity acted upon by the retarding force of friction. His remarks were of great interest, and as the NEWS publishes all matter of interest in regard to the jetty question—on both sides, whether in favor of or against the system—an abstract of Col. Robert's remarks will be found below. He sees no reason to alter the opinions he formed when one of the members of the Commission of Engineers on whose favorable report the Congressional appropriation was made and the jetties begun, which is that the success of the jetties is sure. Col. Roberts' remarks will be read with considerable interest, and his courtesy in giving his paper for publication by the NEWS, duly appreciated by its readers. C. J. M.

The Motion and Operation of Rivers.

BY COL. W. MILNOR ROBERTS, C. E.

Practically, as we know, there are only two prime causes to consider in the motion and operation of rivers; namely, gravity and friction. Yet it will be found that no two rivers are alike, and often they differ in important features, which may constitute their distinctive characteristics; so that, while the principal elements are so few and simple, it is exceedingly difficult either to establish or to apply formulæ in the practical study of any one, or in the comparison of two or more rivers. As compared with rigid formulæ, the physical differences of streams, arising from differing climatal causes, differing declivities, volumes, depths, widths, and curvature, and difference in the nature of the material of the wetted perimeter, etc., are greater than might be imagined by those who have not enjoyed opportunities of noting them in practice.

The entrance of each tributary changes the regimen of that part of the main stream and below. The particular angle at which it enters, may materially affect the flow of the main river, accordingly. Flood action, especially, in large rivers like the Mississippi, and the Danube, with numerous tributaries, is greatly affected in a peculiar manner, by the rising and falling of 'different tributaries at different periods instead of their simultaneous action; so that the lower portion of the river may be in flood while the upper portion may be suffering from drouth. Or, as in the case of the Nile, which is however *sui generis*, the upper portion in its equatorial regions may be well supplied, while the lower Nile and its two great discharging outlets, the Rosetta and Damietta branches may be nearly dry. Here, although the action of gravity is unceasing, the evaporatory power of the warm, dry, rainless climate is sufficient after the annual floods have passed out, to carry off into the air circulation an immense quantity of water on its way from its equatorial sources to the Mediterranean. The Nile has not a single tributary for nearly fifteen hundred miles above its delta mouths.

It is thus the very reverse of the Mississippi, which has more important tributaries, and a moister climate toward its mouth than it has near its head. Some streams pass through rocky regions, taking down little sediment; others through alluvial territory carrying large quantities of detritus; others pass through different regions, as in the case of the Mississippi. Some of little and regular fall; others great and irregular fall. Some freeze; others do not, etc.

Again, the regimen, and general characteristics of large rivers may be radically different on different portions; this is especially the case in delta rivers, like the Mississippi, the Danube, and the Nile. An engineer might be thoroughly familiar with the physical characteristics and operations of the upper Mississippi or Missouri, and ignorant of, or but partially acquainted with those of the lower Mississippi. Even the deltas of different rivers are quite dissimilar, in important respects. Yet gravity is invariably the primary element to be considered in all cases of river motion, whether near their sources or at their mouths.

The deltas of rivers debouching into fresh water lakes differ from those of salt water lakes or seas. The deltas of rivers discharging into salt seas, gulfs, or estuaries, as the case may be, also differ. The deltas of strongly tidal waters are different from those of non-tidal or slightly tidal waters, and the respective regimens of the different delta streams for some distance above the mouths are affected accordingly. Yet gravity, in all these cases, is the controlling element. The greater specific gravity of sea water necessitates the flow of the lighter fresh water from a river outlet, on top of the sea water, requiring distance, and time, for the gradual commingling of the two kinds of water; so that a large river, during its flood discharge, may send its fresh water many miles to sea, forcing, by its momentum, the heavier salt water aside, and, somewhat like the gulf stream, establishing as it were a river through an ocean. (Though in the case of the gulf stream the water is salty, and only specially lighter because of its higher temperature acquired in the equatorial latitudes and in the Gulf of Mexico.) In the case of the river Amazon, which discharges by a single very wide mouth directly into the ocean, the discolored river water has been seen at the distance of one hundred and fifty miles from the coast. On the other hand, the river Nile which debouches into the Mediterranean through its delta, when at its lowest stage discharges very little fresh water, and the sea backs up for miles, leaving the outer portion of its extensive delta almost wholly at the mercy, so to speak, of the winds and waves, and the tides, which are there usually only about eighteen inches in height.

The specific gravity of the sea water being from two to three per cent. (averaging perhaps 2½ per cent) greater than that of fresh water, its gravitating force when elevated into waves by the wind, is to that extent greater than fresh water waves of similar height. For the same reason a discharge of an equal volume and depth of salt water upon an equal declivity, has a greater scouring power than fresh water. The greater gravity causes it to move with greater velocity, and, being specifically heavier, its scouring power is thus proportionally augmented.

The scouring power of a fresh water river depends of course upon its velocity and volume where it impinges against the material to be scoured; and that velocity, in the general, is created by the declivity, modified by the depths of the stream. The difference of level of its surface, on a given distance, is the measure of its gravitating power; which in connection with its depth and volume gives the measure of its momentum. This is the general proposition, and in all cases gravity and friction must determine the results. It would be easy to make river formulæ, if friction, in river practice, were as regular and rigid as gravity; which it is not. The impinging of the flow of water against the wetted perimeter is one reason of the frictional resistance, the atmosphere is another, bends in the river another, irregularity of bottom profile another; but all are resolved into friction as a retarding force; the combined effect of which is to reduce the natural rate of flow due to the regularly operating force of gravity.

Let us take a look at the one grand delta of our own country—that of the Mississippi river, in connection with what is going on there under the auspices of the government, by a special agreement entered into between the Congress of the United States and one of the members of our Society of Civil Engineers.* I had no intention when I began this paper of making any reference whatever to that special work; nor will I at present enter into the merits or demerits of different methods of improving the outlets of delta rivers, or into the details of that particular agreement. From the perusal of recent articles which have come under my notice, it has occurred to me that portions of the criticisms, and studies of the Mississippi river and its delta, and of the probable effect of the confining piers or jetties, appear to rest upon incomplete knowledge of some of the facts and circumstances, which have for ages controlled and still control the main features appertaining to this delta. There is no mystery whatever connected with these features; unless it may be the slight one, the formation of the peculiar, local "mud lumps"†; and these are not of sufficient importance to demand any change in the method of treating the South Pass outlet by artificial works.

Many centuries have elapsed since the Mississippi river, through the power of gravity, first filled the old gulf bed, and, afterward, by the same power excavated its present broad, one hundred feet deep channel at the present site of New Orleans, which channel continues with immaterial variation of depth and width, for about one hundred miles below, to the head of its three great discharging "passes," as they are called. Nor does history record when these three passes were formed. They are the South West, 18 miles, South, 13 miles, and (properly) North East, 15 miles, measured from a common point at their head to deep water in the gulf, beyond their outer bars. Assuming an average length of about fifteen miles, and an annual rate of progress of the delta of two hundred feet, seaward, it must have occupied three hundred and ninety-six years; but this is but a vague assumption. For some years the bars at the South West and North East passes have been moving seaward at a more rapid rate than the bar at the South Pass, which, I think, is chiefly, or perhaps wholly, ascribable to the fact that their volumes of discharge of the sediment bearing water, are so very much greater; these passes being double the width, and considerably deeper than the South Pass. At each of these passes, the river, by the power of gravity, causing scour, carries forward a deep channel, and forms its own section and river banks; but the circumstances which have formed the great, gradually extending bar and the entire delta, with a present front of more than forty miles, are ever in action, to-day, as they have been for ages, to prevent the natural river flow from cutting through its own bar with its normal river depth till it should meet a similar depth in the gulf.

Now, let us ask, what are these circumstances? for the whole matter is in this nut shell. We have:

1. A gulf of salt water of vast area, and of increasing depth as we advance from its coasts, into which the river, mainly through these three passes, discharges its fresh water with sedimentary material.

2. Beginning for the present purpose, at New Orleans, we have: A broad, deep river, practically nearly straight, running southward to the head of these three passes. We need not here pursue the question of when or how the head of these passes originated; we know that the Mississippi river has made its own channel more than one hundred feet deep, and over a half a mile wide for about one hundred miles below New Orleans, and made its three river outlets from thirty to fifty ft. deep, respectively, extending from ten to thirteen miles from a common point at the head of the passes, to where their beds begin to slope up on the inner or river side of the bar.

At the South West Pass, the natural bar is about five miles across; at the North East passes (for there are two main prongs there, called the South East Pass, and Pass a Loutre) about four miles across; and at the South Pass about two and a quarter miles across.

3. The tide, in this part of the gulf is as a rule diurnal, only; and usually of moderate height. Fourteen inches is considered to be the height of the ordinary tide; though at times it is two feet or more, and, in conjunction with strong winds, it is occasionally though rarely, three feet or more. The prevailing winds are from the eastward, or *across* the natural flow from the South Pass; the prevailing winds next in frequency and force, are from the west, and across the natural flow. Northerly winds have the effect of hastening the discharge or outflow through this pass, while southerly winds have the effect of checking the outflow, and of piling up a retarding sea in its front. When the flood tide is at the same time running in, this retardation is augmented, when the ebb tide is at the same time running out, it is lessened.

4. In dead low water of the Mississippi, there is so little fall in the river between New Orleans and the head of the passes, a distance of about one hundred miles, that the tidal effects, though so small, are quite marked, not only at New Orleans, but for many miles above. In floods, the river at New Orleans rises fifteen feet above this low water stage, while at the head of the passes it rises not quite three feet. That is, in high water of the river, twelve feet (4-5ths) of the total increased fall or declivity are distributed on the hundred miles and, in round numbers, three feet (1-5th) between the head of the passes and the gulf—a distance of thirteen to eighteen miles—(or, counting only to the end of deep water within the passes, from about from ten to thirteen miles).

There is however another circumstance in this connection, to be borne in mind. In very high floods of the river, when aided by winds, the river overflows its low banks below the head of the passes, and thus pours out a considerable portion of its waters and sediment laterally; and immense quantities of its waters and sediment are also discharged at such times through what is called the "Jump," (twelve miles above the passes) and through "Cubitt's Gap," (five miles above the passes). With a fall of twelve feet in one hundred miles (1.44 in. per m.) in a river more than half a mile wide, and much of the way over one hundred feet deep in its channel, the velocity ranges above six miles an hour; and at such periods the tide, and the wind, exert comparatively slight influence in the main river, and of much less than ordinary influence in the passes, where there is then an average fall of about three feet in fifteen miles, or 2.4 inches per mile, with channel depths of thirty to fifty feet. (South Pass about 700 to 800 ft. wide, South West Pass about 1400 to 1500 ft., Pass a Loutre 1500 to 1600 ft.) Two miles above the head of the passes, the river is one mile wide, and about 45 feet deep in the channel. Nearer the head, within about half a mile of the old "Light" at the upper end of South West Pass, the river is one and a half miles wide, with a depth of about thirty feet. Observe that the river is here spread out to three times its normal width. The natural high water scouring power of the river has been considerably reduced by the two large openings, at the "Jump," and at "Cubitt's Gap." This is the case to a material extent on the five miles between Cubitt's Gap and the head of the Passes, and to a less extent on the seven miles between the "Jump" and "Cubitt's Gap."

In low water of the river, its scouring power, and of course its ability to carry sediment, is materially lessened, because its declivity, depth, volume and velocity are reduced to the minimum, and of course its gravitating power to scour is correspondingly reduced to a minimum. The current is then less than three miles an hour, and is more easily affected by the gulf tides, and the winds. At times, with a strong easterly wind, when the river is at its low stage, sea water pours into the river through Cubitt's Gap from the gulf waters. On such infrequent and temporary occasions, this would to some extent assist the scouring power of the passes, but in general, these two large openings, by discharging a considerable per centage of flood water, take off just so much gravitating power, which would otherwise aid in scouring the passes. It is true that a portion of the sediment is thus thrown out laterally, and kept from directly extending the outer bars, but this is probably insignificant compared with the curtailment of the natural scouring power. At most, it could only retard to that extent the immediate advance of the front of the delta. The delta itself, in the long run, counting by centuries, would move outward at the same rate. At the very lowest stage of the river there is an immense volume of water passing out, with very little sediment.

5. These are the principal facts and circumstances to be studied in connection with the mouth of the Mississippi; some of which may not be found at any other great river delta.

The leading idea of the mixed commission of engineers who recommended the trial of the jetty system at the South Pass bar, was, to carry through the bar to deep water in the gulf, practically the same cross-section that has existed for many years in that pass; namely, seven to eight hundred feet width, with a channel depth of thirty feet. The centre lines of the jetties are placed one thousand feet apart, leaving sufficient space, to admit of precisely such a channel as the South Pass itself has already formed for ten miles. There was no intention of drawing off water from other passes to the South Pass; but merely to hold in that pass its normal quantity.

At the head of the South Pass, and just within it, there is an island, and on each side a channel between four hundred and five hundred feet wide, in which there was a reliable depth of not more than about fifteen feet on one side, and ten to twelve feet on the other. It is

*Captain James B. Eads, C. E., of St. Louis, who is also a member of the British Institution of Civil Engineers.

†The writer read a special paper upon this subject nearly two years ago before the mixed committee of military and civil engineers of which he had the honor to be a member.

known that this island has been formed, by the river itself, through some local action, within the last forty years. It was not there in 1838. Below this island, and even abreast of its lower portion, there is forty feet depth of water; but above it, and generally for a third of a mile above the head of the passes, is a wide shallow river bar.

The commission referred to, contemplated the treatment of this bar upon the same general principle, with modifications, as that to be applied at the outer or gulf bar. That is, to confine the water by means of piers or jetties built up to the surface, so as to give a cross section similar to that in the South Pass below the island. When completed, this would only allow a quantity of water due to that cross section to flow from the main river into the South Pass. It was anticipated as probable, that some artificial dredging might be necessary in the first instance to secure the required depth at the head of this pass; although afterward, the natural flow, it was believed, would be sufficient to maintain it.

It was also expected by some of the members of the Commission that considerable dredging at the outer bar might be necessary, in order to obtain, at an early date, the full depth and width demanded; and an estimate for that purpose was included in the report. Some members, however, were of the opinion that no dredging would be necessary; that the force of the river would be adequate to remove the bar between the jetties, and to cut the desired width and depth of the channel. Experience has proved that the natural flow between the jetties, which now includes the quantity formerly passed out of the South Pass by Grand Bayou, has already cut a channel 22 feet deep, and about 200 feet wide, through the flat bar, which had a natural depth over it of only seven to nine feet, for more than a mile. There is now a deeper, wider, and more commodious ship channel entirely through the South Pass Bar than has ever been obtained by other means at either of the other passes. It is at least four feet deeper, and double the width ordinarily maintained by the government steam scrapers either at Pass a Loutre or at the Southwest Bar; and this has been accomplished through private means, and in less than a year and a half since the work was begun.*

There has been an erroneous impression, as I deem it, in the minds of some engineers who have not been on the ground and made themselves familiar with all the circumstances, in regard to the general stability of the present passes. It may be admitted that local circumstances may, in the future, as in the past, cause fluctuations in the depths of the natural channels which exist through the bars at the several outlets; but it does not follow that any one of the main passes is "dying out" as it has been expressed, excepting only in regard to its navigability at the bar. Nature's depth, at the great outlets of the Mississippi, on the bar, appears to have been for two hundred years, or more, about fourteen feet; sometimes a little more, sometimes a little less. By artificial means, such as stirring and scraping, etc., this has from time to time been increased to sixteen, seventeen and even eighteen feet; and the expenditure of two hundred and fifty thousand dollars per annum has not succeeded in effecting anything beyond this. No artificial works that I am aware of, of any kind, have ever been tried at the outlet of the South Pass till now, and every one can see here from what has been stated, the effect of the concentration of the outflow between jetties. It is like changing numerous small perforations at the end of a water spout to a single nozzle. The gravitating power heretofore spread out over several hundred feet in width of a bar, being concentrated and forced to flow within the limits of less than one thousand feet, must do one of two things: it must cut for itself a deeper section, if the material is movable by the action of the river, or, if it is not thus movable, it must raise the surface of the water between the jetties. In this case the material being sand and mud, the river has selected to cut itself a deeper channel. If the material had proved to be much harder, as some apprehended it might, dredging and scraping would have been needed to do that which the current itself is now doing. In that case, the natural flow might be adequate to *maintain* a channel intact, that it was not powerful enough to cut out in the first instance.

If extension of a pass into the level gulf is to be the cause of the "dying out" of a particular pass, the South Pass, which is five miles shorter than the Southwest Pass, may have a long lease of life; for at the rate of even two hundred feet per annum advance, (whereas it has only advanced about one hundred feet per annum for many years) it would require one hundred and thirty-two years to be as long as the Southwest Pass; but from the manner in which it appears to operate, it does not seem probable that the advance at the South Pass will be ever as rapid as was estimated and allowed for by the Commission of engineers, which I think was one hundred feet per year, taking a long period of years. At present the gulf immediately in front of the outer end of the jetties is not filling; on the contrary it is being cut away.

Bearing in mind that the general course of the jetties, as well as of the new channel, is southward, while the direction of the prevailing winds is westward, and eastward, it will readily be seen that an immense volume of water, which with a strong easterly wind formerly moved freely to the west over the wide bar with a depth of seven to nine feet can do so no longer. The jetty embankment prevents it, and the salt water at such times naturally piling up against this embankment is forced to turn and flow to the extreme outer end of the jetty, seeking a lower level, and there encountering the strong fresh water river current passing out from between the jetties, the salt water cuts under it and carries the loose material, if any be there, with an under current westward, and so only on the reverse order, with a strong wind piling up a sea from the west.

The sea action has already filled in a large amount of material on the outer side of each jetty, as it was anticipated it would; and according to my judgment the day will come when occasionally heavy storms from the east or west, as the case may be, may wash some bar material over the jetties; but whatever may come in in that way will be swept out by the river current to sea.

I think that hardly enough consideration has been given to one fact in connection with jetty concentration of outflow, upon which I have heretofore placed much stress: First, that before concentration, the river had to do absolute uphill business, on a wide front, the moment it reached the inner side of the bar, rising from a depth of thirty feet to a depth of only eight feet, or twenty-two feet rise in the river bottom in a short distance. Secondly, with greatly reduced velocity, it had to push itself across a flat sand bar for about two miles, offering friction over a front several thousand feet wide, the river losing velocity at every foot of its spreading advance; and being less and less able to cope with the resisting sea water. Thirdly, by the time it had gone over the two miles of bar it was ready to drop, and did drop portions of its load of sediment, and could only push along, slowly, other portions of sediment on the surface of the bar; then soon becoming lost or spread widely out on the ocean of salt water beyond the bar, and dropping all of its sediment within a comparatively short distance of the bar.

Whereas, when all this water shall be concentrated by means of the jetties, with a depth entirely through the bar equal to the river depth in the pass behind, the river water will move out *on a level*, without being forced either to rise or to spread laterally. It will flow out from the extreme ends of the jetties like a jet from a nozzle under water, with nearly its normal river velocity. No portion of its sediment can be then permanently left in the channel between the jetties; nor generally can any considerable portion of the sediment be dropped immediately after passing the jetty ends, because of the velocity of the whole volume of the river flow. If the bottom of the channel is thirty feet beneath the surface, it will be below ordinary wave action in that part of the gulf; and even with a strong wind from the south little or no sediment would be likely to be washed from the gulf back into the jetty channel; and if it were it would soon be carried out again. It may be that at times, with the flood tide making in once a day, and a strong wind blowing in the same direction, with the river at its lowest stage, that a considerable portion of sea water may for the time being enter in between the jetties; but it could do no harm, for at that time there is little or no perceptible amount of sediment carried that far down the Mississippi river. It is then almost clear river water.

When the river is in strong flood, generally very little if any, sea water can enter from the gulf. During such freshet period, with a high flood tide, and a strong wind from the south, there may enter a considerable swell from the gulf, raising the water somewhat at the mouth of the jetty channel, which would naturally check for a time, to some extent, the river current; but it could have no injurious effect upon the channel, nor need it interfere with navigation, unless the wind should amount to a hurricane. Even then I am not aware of any reason why a vessel could not run in from the gulf between piers a thousand feet apart.

SOME MEMORANDA.

The mouth of the South Pass is nearly midway between the mouths of the South West Pass and Pass a Loutre, (which runs south of east) distant about twenty miles from each. Taking a centre point in the main river half a mile above the head of the passes, and striking a curve with a radius eighteen miles long, the curve first touches the outer end of South West Pass strikes five and a half miles outside of South Pass, and three miles outside of Pass a Loutre. On this curved point it is about miles from South West Pass to Pass a Loutre. Counting from five fathom depth outside of these two outer passes the actual irregular curvilinear frontage length of the delta is about forty-three miles. It is irregular in outline because the quantity of material brought down by the smaller outlet (the South Pass) has been much less than that deposited by the other passes.

The extensive bays between the passes are too shallow for ocean vessels. As the delta has advanced into the gulf, from the deposition of the detritus at the outlets of the passes, and from overflow, during floods, over their low, river-formed banks. West of the South West Pass lies West Bay, with only from two to four feet depth of water. Between South West and South passes lies East Bay, with from three to five feet depth. Between South Pass and North *East Pass lies Garden Bay, enclosing a middle tongue of water from seven to ten feet deep, surrounded on three sides by large areas with only about three to five feet depth. Between South East Pass and Pass a Loutre lies Blind Bay, having irregular depths varying from three to eight feet. East Bay and Garden Bay are much the largest; East Bay covering seventy or more square miles, and Garden Bay fifty or more.

All of these bays are but shallow areas of water over the gradually filling delta of sand and mud which lies beneath. The very same general character of material found close to the outlets of the passes, and in the bottom of these bays, is found at the head of the passes, at Fort St. Phillip, forty miles above, and at New Orleans, a hundred miles above; as shown by numerous borings a hundred feet deep made below Fort St. Phillip, and a boring of over six hundred feet depth at New Orleans.

An examination of the material of the different strata passed through by these borings, seems to show, (as I think,) that the frequent changes in the particular character of the material deposited have arisen from two causes: One, the difference in the material brought down by different large tributaries, whose floods have not occurred simultaneously; the other, the difference in the character of the deposits in different stages of the river freshets; the deposits being coarser in proportion to the velocity of the stream at the time, and coarser near the river banks when deposited from lateral overflow.

The deposits, except a few feet at the top of turfy vegetable matter since formed, consists chiefly of horizontal strata of blue clay, yellow clay, loam, fine sand, and coarse sand, without any regular order. Some of the strata are only a few inches thick; especially those consisting of sand.

There is an important feature of the delta which I think has not yet received the attention it deserves; namely, the shape of its present frontage, as compared with that it had at the head of the passes, some hundreds of years ago, possibly nearly as far back as the discovery of America by Columbus. It is obvious that at that time the entire frontage of the discharging passes, allowing that those main passes existed at the present head, could not have been more than two or three miles, whereas now it is about forty miles; the two main outer passes being that far apart.

*If, during the present year, the engineer who has undertaken this work shall, as I think he will, succeed in establishing a better ship channel between the deep water of the Mississippi river and the ocean than has ever existed there, the prediction may be safely ventured that no event of this Centennial period is likely to exert so great an influence as that surely will upon the future of our country, and upon the commercial world generally.

The natural ancient bed of the Gulf of Mexico (although of course in this vicinity it is, as the soundings show, covered with a deposition from the river, of immense depth) shelves off very gradually to a vast depth, being several thousand feet deep a few hundred miles from its coasts. In front of the South Pass, the present slope of the river deposit—which is what the sounding lead strikes—is about one in sixty-four, for two or three miles out. At the other passes the slope is a little flatter; (which may be owing to several causes, such as their position with respect to the prevailing winds, their greater discharge of sediment in a given time, the action of sea currents outside, and difference of tidal action at the several passes, etc.).

The advance of the deposit upon the natural floor of the Gulf is in the shape of a very blunt wedge, moving butt foremost, or of more than the quadrant of a circle moving with its circular portion seaward, so that every hour the area of the gulf subjected to this river deposit has been for these hundreds of years enlarging and is to-day enlarging. Consequently the rate of advance of the delta as a whole must be decreasing.

Measurably, the deposit is, in the first instance, dropped somewhat like the dumps of an embankment; but it resembles most an embankment carried out at right angles to the flow, in a tidal stream, where the material is immediately acted upon under water by the currents, and large portions, if it be sedimentary and easily moved are carried up stream, or down stream, laterally, away from the line of the advancing bank.

The topography of the passes and their immediate shallow bays, show precisely what the process has been, and what under similar circumstances it would continue to be; but these are, as above indicated, being gradually modified every hour, by the widening area to be filled, and the increasing spaces between the diverging passes which ultimately receive large quantities of the sediment. The tides, which, some hundreds of years ago, when the passes were confined to one locality, acted of course simultaneously and alike upon all, now occur, with differing currents at separate intervals of time; and the several passes present essentially different fronts to the prevailing winds and ocean currents. The general course of Pass a Loutre, for instance, is considerably north of east, while the course of the South West Pass, forty miles distant, is about southwest, showing a divergence of over one hundred and fifty degrees.

While the head of the delta has thus so extensivly widened out, involving, in the nature of the case, a slower future rate of advance into the gulf, on account of the circumstances already described, there is another action induced by the situation of the outlets in relation to the gulf. The farther the head of the delta projects into the gulf, and the larger its front range, the more it is submitted to the lateral action of the tides and wind currents in distributing the detritus from the river. The more rapidly and effectually this lateral distribution of sediment, carrying and dropping it into the comparatively still bays, the slower must be the general progress seaward.

At the South Pass, improved by jetties, with its whole concentrated volume flowing out in a deep stream, with a velocity sufficient to carry the bulk of the suspended sediment a considerable distance seaward before any large proportion of it would be dropped, a new feature is added. The side dumping or lateral distribution of the material, will take place much faster out from the delta than when the same quantity of water spread out only about 8 feet deep, and commingled with the sea water over a bar two miles across, and extending for miles on each side. Keeping in mind all the premises, and the causes now operating at the South Pass, there is, I think, fair reason to anticipate that upon the completion of the work in progress—both on the outer bar and at the head of the pass, the country will have secured a deep ship channel, which can afterward be maintained at very moderate annual cost.

NOTES.

They want a bridge at Oregon City to span the Willamette.

The stone for one of the piers to the Viaduct arch over the Atlantic and Great Western Railway, in Cleveland, is being laid.

A large force of men is now at work on the new County buildings at Cleveland, and their final completion is not far distant.

Mr. Roy estimates the available coal in the Alleghany coal field at 703,424,000,000 tons.

A Russian Congress is to meet at Warsaw next September, at which the question of adopting the Georgian Calendar in Russia will be considered.

The Swedish Diet lately voted the adoption of the French system of weights and measures, with the French nomenclature. Its obligatory use is to date from 1889.

THE Dutch government is about to construct a great port, canal and railway Tandjory Prisk near Batavia, Island of Java, Dutch East Indies. The cost will be about £1,900,000.

THE Wrought Iron Bridge Company, of Canton, are running fourteen hours a day on contract work, and have contracts ahead to keep them busy for nine months to come.

Violle has experimentally investigated anew the question of the Sun's temperature. He arrives at the result, that the mean temperature of the sun does not differ sensibly from 2500° C. He gives 1300° C. as the temperature of Siemens-Martin steel when running into the moulds.

The several skeins of the cables for the suspension bridge at Minneapolis are in place and the wrapping of the cable will be completed by the middle of November. The grading for the approaches has been let, and the superstructure of the bridge itself will doubtless be completed by spring.

The new tunnel being built under the Thames is intended chiefly for the use of about 8,000 workmen who have to cross at that point, and who are often detained by fog that stops the boats. It will be an iron tube nine feet in diameter, lighted with gas, thoroughly ventilated, and only for pedestrians.

Two bogus bids were received at the Department of Parks for the work on Riverside-ave, New York City, which has been opposed so strongly by Controller Green, In one of them, by "Hunt & Conkling," the affidavits are all forgeries, and the address. No. 404 Ninth ave., proves to be an asylum for the blind.

A new iron bridge is being built over Market street, Springfield, Ill., in place of the old wooden one, at the crossing of the Chicago and Alton Railway. The span is 80 feet, the track 15 feet above the roadway. It is built by the American Bridge Co. of Chicago. One of the abutments coming over the city sewer, a heavy stone arch was necessitated.

The committee on the new City Hall of Brooklyn, Oct. 12, opened 45 bids for work, of which the following were the lowest: Marble work, J. M. Masterson, $28,200; mason work, George Hadden, $64,798.74; carpenter work, J. Fallon, $38,000, and E. Snedeker, $36,730; plumbing work, M. Kessel, $5,432, and S Hurley, $49,443; iron work, D. D. Boyce, $47,381.

The improvements in steamship engineering is well illustrated by the time made during the summer of the new steamships, Germanic and Brittannic, of the White Star Line. The average of five trips of the Germanic was 7 days, and slightly less than 20 hours. The average of five trips of the Brittannic was 7 days and 20 hours and 5 m. This time was between Queenstown and New York. The distance is about 2800 miles, which gives an average speed of about 15 miles per hour.

THE stone work on the new bridge which is to span the Monongahela at the "Point," Pittsburgh, was completed about a week ago. Mr. John Megraw, of Allegheny, was the contractor, and the contract amounted to nearly $200,000. The most of our readers are probablo aware that the American Bridge Company, Chicago, are erecting the superstructure, which is of iron. A large portion of the iron work is done in Pittsburgh.

MR. MULLET, the former Supervising Architect, has been appointed to superintend buildings now erecting, for which he made the designs while in office, viz., the post-offices and custom houses at Philadelphia, New York, Cincinnati, Chicago, St. Louis and Hartford. The Chicago post-office will probably be finishhd according to the modified designs of Mr. Potter, in deference to the committee of experts who decided the coriginal design unsafe on the present foundations.

Railway News.

GROUND was broken on the Rhode Island & Massachusetts Railway about a fortnight since.

A railway is contemplated from the Port of Jaffa to the City of Jerusalem, Palestine, to be built under Roman Catholic Patronage.

The work of laying the iron on the railroad extension west from Appleton, Wis., progresses at a rapid rate. It will surely be completed to New London this fall.

A road 45 miles long, from Conejos to Tierra Amerilla, opening up the San Juan country, Col., will be built next spring.

One thousand workmen, in the shops of the Delaware, Lackawanna and Western Railroad Company, struck Friday, in consequence of a reduction of 10 per cent. in their wages.

The line from Steven's Point to Portage City will be finished by the 18th inst. This branch constitutes 72 miles of the new road, constructed within a year; the only long line of road built in Wisconsin this year.

The Ottawa *Free Press* says: "We believe that for section fifteen of the Canada Pacific railway, the lowest tender, that of Messrs. Macdonald, Kane & Co., of Montreal, has been accepted. The amount is $1,443,175."

A railroad company has just been organized to build a line of road from Council Bluffs to Pattonsburg, Mo., there to connect with the St. Louis, Kansas City and Northern railroad for St. Louis. The name of the road is the Council Bluffs, Eastern and St. Louis railroad.

Work will shortly be resumed on the Coldwater and Marshall Railwry, Mich. From Coldwater to Elm Hall, 110 miles, the road is practically ready for the rails, and they will probably be laid as far as Marshall this autumn. Ultimately the road will be extended to the Straits of Mackinaw.

Work on the Wheeling and Lake Erie narrow-gauge Railroad has been commenced between Milan, Erie county, and Norwalk, Huron county, Ohio. A large force of men is engaged, and the work is being pushed forward rapidly. The intention of the contractors is to complete the section between Norwalk and Sandusky by January 1st, 1877.

An engineering party in charge of A. B. Rogers, has been sent out by the Milwaukee St. Paul R. R., to survey the proposed extension of the Hastings and Dakota from Glencoe, its present terminus, to Granite-Falls, Minn. The intended extension is through a beautiful wheat country and it will finally reach into the wheat lands of Dakota.

The switch of the New York Elevated Railroad at Fiftieth street has been finished. In about three weeks the company will put on several new cars, and run trains from each station every 7½ minutes. On Oct. 9th the trains carried 8,485 passengers, the largest number in a single day since the road was opened.

The projected east and west road, which was undertaken some years ago in opposition to the Boston and Albany, and partially built in sections, may yet be completed, as a proposition to change its gauge to three feet and make it the eastern terminus of a great narrow-gauge road to the West is being discussed.

Amended plans have been presented, with a view to the completion of the St. Gothard railway upon a more economical basis. The estimates have been cut down to $10,000,000, as compared with $20,000,000. A conference of Swiss and Italian delegates is to take place shortly with reference to the undertaking.

The Pensylvania Railroad Company are ballasting the whole of their road between New York and Philadelphia with broken and screened stone. The stone is laid upon the road bed to the depth of four inches, and also on either side of the tracks, so that no dust is created by moving trains. The ballasting has been completed from Newark to Hackensack bridge.

The Missouri, Kansas and Texas road is now negotiating the purchase of the Red River and Rio Grande Railroad charter, which road commences at Sherman, Texas, running in a southwesterly direction to Weatherford, and thence via Pacific and Great Eastern to or near Presidio del Norte, on the Rio Grande, thence through the rich silver districts of Mexico at Chihuahua, and to the Pacific at Altalta, mouth of Gulf of California.

IMPROVEMENT OF RIVERSIDE AVENUE.

Department of Public Parks, 36 Union Square, New York.

SPECIFCATIONS. (*Continued from page* 326.)

The flagging shall not be laid on frozen ground.

The price bid for flagging will be in full for furnishing all the material and labor necessary to permanently place the stones in position, in accordance with these Specifications.

Cross-walks. 61. Where directed, cross-walks shall be laid of the best quality of granite, free from saps, seams, or other imperfections. The stones to be of the dimensions in each case directed; unless otherwise directed, they are to be not less than four feet long and two feet wide, and not less than six nor more than eight inches thick throughout; dressed to an even face on top and bottom, with sides and ends square and full, and to be cut, so as to lay to a joint not exceediog three-eighths of an inch from top to bottom.

The stones are to be well and firmly bedded on a foundation of sand or gravel, and laid with joints not exceeding three-eighths of an inch. The courses to be laid so as to break joints. The pavement to be adjusted to the lines of the cross-walks. The price bid for cross-walks will be in full for furnishing the materials and labor requisite to comply with these Specifications.

Granite steps. 62. Granite steps shall be provided and set in accordance with plans. These steps shall be of the dimensions and lengths, shown on plans. Their upper surfaces, their faces and a portion of under surface, as shown on plans, are to be fine cut work, the rest of the stone to be pointed off to dimensions given. Where the step rests on the rubble foundations, they are to be cut so as to lay to one-quarter inch joints. The stones are to be perfectly true and straight to lines, without winding. They are to be of the best quality of granite, free from all imperfections and satisfactory to the Engineer. They are to be laid in cement mortar. The price for granite steps will be in full for furnishing and setting them permanently, as herein specified.

Foundation for steps. 63. The foundation work for these steps to be rubble masonry, in cement, in accordance with plans, and built as hereinbefore specified for rubble masonry and in all respects as shall be directed. It will be paid for at the price bid for rubble masonry in cement.

Excavations or fillings for foundations. 64. In preparing for the foundations of either the drives, roadways, rides walks, or other constructions herein specified, and shaping the materials to the sub-grades directed, if any excavation or deposit of new material be required, in addition to the excavation or filling that may have been previously made, and in addition to the stone, gravel, or other materials used in the said pavements or constructions, such additional excavation or filling shall be made and provided at the price bid for excavation or for embankment as the case may be.

Trestle work. 65. The different trestle-works to be put up wherever required, as will be shown on plans, and as will be directed.

The timber to be of the best quality Georgia pine, well seasoned, and to be free from sap, splits, large loose knots, and other imperfections.

The principal posts to be set into cast-iron sockets, of suitable size, resting on granite piers, as shown on detail drawings.

All posts to be well mortised into the girders, and the braces to be framed into the posts and girders, and to be secured to each other with strong wrought-iron bolts and straps.

The cross-beams to be laid on the girders, and spiked to the same with spikes of suitable size.

The floor to consist of two thicknesses of best quality Georgia pine plank, the first layer to be 3 inches thick, the second layer 2 inches thick, well spiked to the beams.

The railing on either side of each trestle-work to be constructed of a frame-work, as shown on detail drawings, properly secured to beams, with angle irons, etc.

The entire framing of the above specified trestle-work to be done in the best workmanlike manner; all mortices to be cut true and square, and to be tightly fitted.

Wherever the posts or braces come in contact with any masonry, or rest on or against the same, requisite footings must be cut into said masonry by the Contractor, as directed.

The style of framing, number of posts, beams, etc., all to be done and furnished in accordance with drawings, and the entire structures to be put up and fastened together with all the necessary bolts, straps, spikes, etc., in the most thorough and workmanlike manner, as directed by the said Department.

Inspection of materials and work. 66. The whole of the material to be furnished, and all the work to be done, under this agreement, shall be subjected to the inspection and approval of the Engineer, or of his assistants, and of such inspectors as shall be appointed for the purpose. Any materials furnished, or work done, which shall not conform to these Specifications, to the satisfaction of said Engineer, shall immediately be removed or taken up by the Contractor, at his own cost and expense; and other materials or work satisfactory to said Engineer shall be furnished and done.

Engineer. 67. Wherever the word Engineer is used in this Agreement, or these Specifications, it refers to and designates the Superintending Engineer to be appointed by the Department of Public Parks, or such other Engineer as shall be designated by the said Department.

Contractor. 68. Wherever the word "Contractor" or the words "party of the second part," or the pronouns in place thereof, are used in this contract, they are to be considered as referring to and meaning the party or parties, as the case may be of the second part to this agreement.

Engineer to explain specifications. 69. Any doubt as to the meaning of these Specifications, or any obscurity as to the wording of them, will be explained by the Engineer; and all directions and explanations required, alluded to, or necessary to complete any of the provisions of these Specifications, and give them due effect, will be given by the Engineer. All stakes or marks established by the Engineer shall be carefully protected and preserved by said Contractor until their removal is required, in the opinion of the Engineer, by the prosecution of the work.

Orders to overseers. 70. Whenever the Contractor is not present on any part of the work, where it may be necessary to give directions, orders will be given by the Engineer, his assistants and inspectors, to, and shall be received and obeyed by, the superintendents and overseers who may have immediate charge of the men employed on the particular work in relation to which orders may be given.

Incompetent or vicious persons to be removed. 71. The Contractor shall, when required to do so by the Engineer, remove from the work, any overseer, superintendent, laborer, or other person employed on the work, who shall refuse or neglect to obey the directions of the Engineer, his assistants or the inspectors under him, in anything relating to the work, or who shall perform his work in a manner contrary to the specifications and directions of the Engineer, who shall be deemed by the Engineer to be incompetent or unfaithful, or who shall commit any trespass on public or private property in the vicinity of the work, or for any improper conduct.

Defective work not accepted. 72. No work will be considered as accepted which may be defective in its construction, or deficient in any of the requirements of these specifications, in consequence of any negligence of any Inspector or subordinate Engineer to point out said defect or deficiency during construction; and the Contractor will be required to correct any imperfect work, whenever discovered, before the final acceptance of the work.

Guards, etc., of cross streets. 73. The Contractor shall erect and maintain, at all cross streets open to public travel, sufficient fences and guards, and maintain lights at night, from sunset to sunrise, to prevent accidents to persons and animals, and shall comply with all ordinances of the City, in relation thereto, during the construction at such places.

Loss or damage. 74. All loss or damage arising from the nature of the work to be done under this agreement, or from any unforeseen obstructions or difficulties, which may be encountered in the prosecution of the same, or from the action of the elements, or from incumbrances on the line of the work, or from any act or omission on the part of the Contractor, or any person or agent employed by him, not authorized by this agreement, shall be sustained by said Contractor.

Work to be prosecuted where directed. 75. The work under this agreement is to be prosecuted at and from as many different points, and in such parts af the avenue, and at such different portions of the various works embraced herein, as this Department shall, from time to time, determine.

Work to be prosecuted at different points. 80. The work shall be begun within ten days after the execution of the contract, at at least five different points on the work, such points to be approved by the Engineer; and, at each of these points, shall be vigorously prosecuted.

Various kinds of work to be prosecuted simultaneously. 81. As far as may be practicable, the various kinds of work embraced in this contract shall be prosecuted simultaneously. The Contractor shall keep upon the work sufficient skilled men to accomplish this result.

Workmanship and materials. 82. It is expressly agreed that the workmanship shall be performed in the best manner; that the materials of all descriptions shall be of the best kind, and that such number of laborers, mechanics, teams, foremen and other force, shall be at all times employed as shall, in the opinion of said Department, be sufficient to complete the work within the time herein provided. It is also agreed, that said Contractor will, as the work progesses, provide material at as many points as may be directed, and supply such labor as may be necessary, to prosecute the various kinds of work hereinbefore specified, in such order, to such extent, at such times, and with such reasonable speed, as said Department shall from time to time direct, as requisite to complete the whole of the work in the specified time.

Sufficient force to be employed to complete the work.

To be satisfactorily finished. 83. It is also agreed that the work shall be finished in a manner satisfactory to said Department; that the grades and lines shall be truly kept; that the slopes shall be as directed, and shall be nicely shaped; that the spaces for trees and for planting shall be filled to the established grades with good soil; that the masonry shall be cleaned up, and that all parts of the work shall, on completion, be in good order and condition.

Cleaning up. 84. Upon the completion of any portion of the work, all earth, sand, rubbish, refuse-stone, and surplus materials are to be removed, and the Avenue in all respects put in clean and orderly condition. Until this is done to the satisfaction of the said Department, the work will not be considered completed.

Water pipes not to be damaged. 85. The said party of the second part hereby further agrees to take every reasonable and necessary precaution to prevent damage or injury to all main and service water-pipes which may be affected in any manner by the prosecution of the work under this agreement; and if it shall be necessary to remove or change in any manner the location or grade of the said water-pipes, by reason of the construction of the work, to the established grades and plans, the said party of the second part shall give notice thereof, in writing, to the Engineer, at least forty-eight hours previous to commencing the work at the point or points which may be affected; or, failing to do so, any damage or injury that shall or may result to said pipes, the said Department shall be, and is hereby, authorized to repair immediately, and the cost thereof shall be charged to the said party of the second part; and the cost so charged to the said party of the second part shall be paid to the said parties of the first part by him, before the work to be done under this agreement shall be accepted as completed; and the said party of the second part hereby further agrees, in each and every respect to conform to the provisions of the Ordinances, relative to the construction of Sewers in streets where water-pipes are laid; and that the same shall be considered a part of this agreement.

Gas-pipes not to be injured. 86. And the said party of the second part further agrees, to do everything necessary to prevent injury to the gas-pipes which may be liable to injury from the work hereinbefore mentioned; also, to erect, and keep erected, a fence or railing across the sides of the excavation, and place sufficient lights on or near the work, and keep them burning from twilight until sunrise.

And the said party of the second part further agrees, to give notice in writing, at least twenty-four hours before breaking ground, for the purpose of constructing the work hereinbefore mentioned, to such and all such gas companies as have or may, (during the progress of the work) have any gas-pipes which may be affected by such excavation as may become necessary, and it is further agreed, that the said party of the second part shall not cause any hindrance to, or interference with any such gas-company or companies, in protecting their said pipes, nor in removing or otherwise protecting and replacing the main and service-pipes, lamp-posts and lamps, where necessary; but that the said party of the second part will suffer the said company or companies to take all such measures as may become necessary for the purpose aforesaid.

And it is hereby further agreed, that in case any damage or injury shall or may result to the said pipes, lamp-posts, lamps and other works of any gas company, through or by reason of any negligence, carelessness or want of skill on the part of the said party of the second part, the said party of the second part shall become liable to pay such amount as shall or may be sufficient to cover the expense and damage occasioned by such negligence, carelessness or unskillfulness, and such amount shall be charged against the said party of the second part, and may be deducted from any sum or sums due or payable to said party of the second part on account of this contract.

Blasting. 87. The said party of the second part hereby further agrees, that he will obey and conform to all ordinances of the Corporation of the city of New York now in force, or that may be in force during the progress of such work, in relation to blasting rocks, in the streets and avenues of said city.

Engineer's Measurement. (D). The said party of the second part further agrees, that the return of the Engineer, to be appointed by the Department of Public Parks to superintend the work, shall be the account by which the amount of work done shall be computed; and that he shall not be entitled to demand or receive payment for any work upon, in, or about the said work, as extra work, unless ordered in writing, by the said Department of Public Parks, to do the same as extra work, and a price therefor shall have been agreed upon previous to its commencement.

Suspen- (E). The prosecution of the work shall be suspended at such times, and

sion of work. for such period, as the said Department of Public Parks may from time to time determine.

Work to commence When to be completed. (F). The said party of the second part hereby further agrees, that he will commence the aforesaid work on each of the aforesaid several sections on such day, and at such point or points as the Department of Public Parks may designate, and fully complete the same in accordance with this agreement, on or before the expiration of twelve calendar months from the date hereof; not including, however, such time as the prosecution of the whole may be suspended by direction of the said Department of Public Parks; and that he will give his personal attention constantly to the faithful prosecution of the said work, that he will not assign or sub-let the aforesaid work, nor any part thereof, without first obtaining the consent in writing of said Department thereto, but will keep the same under his own control; and that he will punctually pay the workmen who shall be employed on the aforesaid work, and in cash current, and not in what is denominated store pay.

Personal Attention.

Penalty to be exacted for Non-completion. (G). And the said party of the second part hereby further agrees, that the said parties of the first part shall be, and they are hereby, authorized to deduct and retain, at the option of the said Department of Public Parks, out of the moneys which may be due or become due to the said party of the second part, under this agreement, as liquidated damages, and not as a penalty, for the non-completion of the work aforesaid within the time hereinbefore stipulated for its completion, the sum of Twenty Dollars for each and every day after the expiration of said stipulated time, Sundays, holidays, and such days as the prosecution of the whole work may be suspended, as hereinbefore mentioned, excepted.

Deduction from amount of estimate to pay engineering force. (H). And the said party of the second part hereby further agrees, that the said parties of the first part may, and hereby are, authorized to deduct and retain, each month, from the amount due and payable to the said party of the second part on each monthly estimate or payment, as herein provided, and until the whole work is completed, a sum not exceeding sixteen hundred and twenty dollars and sixty-six cents; which said sum shall be paid and applied by the said parties of the first part, through the hands of the Comptroller of the said city, as follows, viz.:

To the Superintending Engineer to be appointed on said work by the said Department, each month, a sum to be fixed by said Department, and not exceeding four hundred and sixteen dollars and sixty-six cents	$416 66
To an Assistant Engineer to be appointed on said work by the said Department, each month, a sum to be fixed by said Department, and not exceeding two hundred dollars	200 00
To a transit man to be appointed on said work by the said Department, each month, a sum to be fixed by said Department, and not exceeding one hundred and twenty-five dollars	125 00
To a leveller, to be appointed on said work by the said Department, each month, a sum to be fixed by said Department, and not exceeding one hundred dol's.	100 00
To a rodman, to be appointed on said work by the said Department each month, a sum to be fixed by said Department, and not exceeding ninety dollars	00 00
To four chainmen, to be appointed on said work by the said Department each month, a sum to be fixed by said Department, and not exceeding seventy-eight dollars to each chainman, in all not exceeding	312 00
To four chainmen, to be appointed by the said Department, to act as inspectors on said work, each month, a sum to be fixed by said Department, and not exceeding seventy-eight dollars to each chainmen, in all not exceeding	312 00
To one axeman, to be appointed on said work by the said Department, each month, a sum to be fixed by said Department, and not exceeding sixty-five dollars	65 00

Certificates, &c., of Engineer, &c., not conclusive as against parties of the first part. (I). And it is hereby expressly agreed and understood by and between the parties to these presents, that the said parties of the first part, their successors and assigns, shall not, nor shall any department or officer of the city of New York, be precluded or estopped by any return or certificate made or given by any Engineer, Inspector, or other officer, agent or appointee of said Department of Public Parks, or said parties of the first part, under or in pursuance of anything in this agreement contained, from at any time showing the true and correct amount and character of the work which shall have been done and materials which shall have been furnished by the said party of the second part, or any other person or persons, under this agreement.

Contract may be declared annulled for violation, etc. (J). And the party of the second part further agrees, that if any work shall be condemned by the Engineer as defective or improperly done, such defective work shall be removed and rebuilt, or the defects otherwise remedied as the Engineer may direct; and if said party of the second part decline, refuse, or neglect to remove such condemned materials, or rebuild or otherwise remedy the effects, or if at any time the said Department of Public Parks shall be of opinion, and shall so certify in writing, that the said work, or any part thereof, is unnecessarily delayed, or that the said party of the second part is wilfully violating any of the conditions or covenants of this contract, or in executing the same in bad faith, it shall have the power to discontinue all work under this contract, or any part thereof, upon giving notice to that effect to the said party of the second part, and thereupon the said party of the second part shall cease to continue said work, or such part thereof, and the said Department of Public Parks shall thereupon have the power to place such and so many persons, and obtain by purchase or hire such animals, carts, wagons, implements and tools as it may deem advisable, by contract or otherwise, to work at and complete the work herein described, or any part thereof, and to use such materials as it may find upon the line of said work, or to procure other materials, in whole or in part, for the completion of the same, and to charge the expense of said labor and materials, animals, carts, wagons, implements and tools to the said party of the second part, and the expense so charged shall be deducted and paid, by the parties of the first part, out of such monies as may be then due, or may at any time thereafter become due to the said party of the second part, under and by virtue of this agreement, or any part thereof; and in case such expense be less than the sum which would have been payable under this contract, if the same had been completed by him, he shall be entitled to receive the difference; and in case such expense shall exceed the last said sum, he shall pay the amoun of such excess to the parties of the first part, on notice from the said Department of Public Parks of the excess so due.

(K). And the said party of the second part hereby further agrees, that he will furnish the said Department of Public Parks with satisfactory evidence that all persons who have done work, or furnished materials, under this agreement, and who may have received or sustained any damage or injury through or by reason of any act or omission, carelessness, or want of skill on the part of the said party of the second part or his agents, in the prosecution of the work aforesaid, and who have given written notice to the said Department of Public Parks, before or within ten days after the completion of the work aforesaid, that any balance for such work or materials, or compensation for such damage or injury, is still due and unpaid, have been fully paid and secured.

And in case such evidence be not furnished as aforesaid, such amount as may be necessary to meet the claims of the persons aforesaid shall be retained from the moneys due the said party of the second part under this agreement, until the liabilities aforesaid shall be fully discharged, or such notice withdrawn.

Indemnification of city. (L). And the said party of the second part further agrees, that he will indemnify and save harmless the parties of the first part from all suits or actions of every name and description brought against the said parties of the first part, for or on account of any injuries or damages received or sustained by any party or parties, by or from the said party of the second part, his servants or agents, in the prosecution of said work, or by or in consequence of any negligence in guarding the same, or of any improper materials used in its prosecution, or by or on account of any act or omission of the said party of the second part or his agents. And the said party of the second part hereby further agrees, that the whole, or so much of the moneys due to him under and by virtue of this agreement, as shall or may be considered necessary by the said Department of Public Parks, shall or may be retained by the said parties of the first part, until all such suits or claims for damages as aforesaid shall have been settled, and evidence to that effect furnished, to the satisfaction of the said Department.

Guards, etc. And the party of the second part hereby further agrees, that during the continuance of the work hereby contracted for, he will place proper guards for the prevention of accident, and will put up and keep at night suitable and sufficient lights around said work for that purpose.

Incompetent workmen to be discharged. (M). And the said party of the second part further agrees, that he will employ only competent, skillful, and faithful men to do the work, and he further agrees that whenever the Engineer shall inform him in writing that any man on the work is, in his opinion, incompetent or unfaithful, he will discharge him from the work, and will not again employ him on it.

Prices. (N). And the said party of the second part hereby further agrees to receive the following prices as full compensation for furnishing all the materials and labor in building and constructing, and for completing in all respects the aforesaid work and appurtenances, in the manner herein specified, to wit.:

1. For excavation of earth, including all solid material, except such as is herein classified as rock, and for the removal, spreading, piling and finally depositing the same, including the proper trimming of slopes, also including excavation of trenches for drainage, all as hereinbefore specified, the sum of.....per cubic yard.
2. For excavation of rock, including its removal and final disposition, including all rock excavation in trenches or foundations, in accordance with these Specifications, the sum of.....per cubic yard.
3. For embankment, as specified, the sum of.....per cubic yard.
4. For furnishing materials and building dry wall of the retaining wall, and its foundations, and also all other dry wall laid, and including also all necessary haul and delivery of stone for such wall, the sum of.....per cubic yard.
5. For furnishing materials and building parapet wall, laid in cement, as herein specified, the sum of.....per cubic yard.
6. For furnishing and setting coping for parapet wall, the sum of.....per lineal foot.
7. For furnishing materials and building all brick masonry, the sum of.....per cub. yd.
8. For furnishing materials and laying concrete, the sum of.....per cubic yard.
9. For furnishing materials and building all rubble masonry, laid in cement, the sum of.....per cubic yard.
10. For furnishing, putting in place and using pile shoes, the sum of.....each.
11. For furnishing and driving piles, where directed, the length actually driven below the point where pile is cut off being measured, the sum of.....per lineal foot.
12. For furnishing and putting in place spruce or pine plank, or timber for foundations or for other purposes specified, the sum of..... per one thousand feet, board measure.
13. For furnishing and permanently placing in position cast-iron, including pipes, conduits, gratings, covers, frames, and all other cast-iron, and including all work connected with its proper fitting and completion, the sum of.....per pound.
14. For furnishing and permanently placing in position wrought-iron, including all work connected with its proper fitting and completion, the sum of.....per pound.
15. For furnishing and building trestle work, the sum of.....per thousand ft., b'rd. m.
16. For furnishing materials and laying twelve-inch straight pipe sewer, and twelve-inch curved and branch pipe sewer (each foot of curved and branch pipe sewer to be estimated and paid for as one and a half feet of straight pipe sewer), including refilling, the sum of.....per lineal foot.
17. For furnishing materials and laying eight-inch straight pipe sewer, and eight-inch curved and branch pipe sewer (each foot of curved and branch pipe sewer to be estimated and paid for as one-and-a-half feet of straight pipe sewers) including refilling, the sum of.....per lineal foot.
18. For furnishing materials and laying six-inch straight pipe sewer, and six-inch curved and branch pipe sewer (each foot of curved and branch pipe sewer to be estimated and paid for as one and a half feet of straight pipe sewer), including refilling, the sum of.....per lineal foot.
19. For furnishing materials and constructing pavement of wheel-way of drive, the sum of.....per square yard.
20. For furnishing materials and constructing pavement of ride, the sum of.....per sq. y.
21. For furnishing materials and constructing pavement of walks, the sum of.....
22. For furnishing materials and laying gutters, the sum of.....per square foot.
23. For furnishing and setting straight granite curb, the sum of.....per lineal foot.
24. For furnishing and setting granite curb angle stones, the sum of.....per lineal ft.
25. For furnishing and setting blue stone curb, the sum of.....per lineal foot.
26. For furnishing and setting blue stone edgings, the sum of.....per lineal foot.
27. For furnishing and setting blue stone edging of special forms, the sum of..pr sq ft.
28. For furnishing and setting circular corners of granite, the sum of.....per lineal ft.
29. For furnishing and setting circular corners of blue stone, the sum of.....per lin. ft.
30. For furnishing and laying flagging, the sum of.....per square foot.
31. For furnishing and laying granite crosswalks, the sum of.....per square foot.
32. For furnishing and setting granite steps, the sum of.....per cubic foot.

(O). And the said party of the second part hereby agrees that the aforesaid prices shall cover the furnishing of all the different materials and labor and the performance of all the work in accordance with this Specification and agreement.

Monthly estimates how made. (P). And the said parties of the first part further agree, that the said Engineer shall from time to time, not oftener than once a month, make an estimate of work partially finished, as the work progresses. The estimate for unfinished work shall not be required to be made by strict measurement, but by measuring and estimating to obtain an approximate result of the work done, and its value under the contract, as compared with the whole contract, on which payments of seventy per cent. of the amounts shall be made as hereinafter provided.

Alterations and specifications. (Q). And it is hereby further agreed that the said Department of Public Parks shall have power from time to time to alter or determine any modifications in the lines, grades or dimensions of any part or parts of the work included in this agreement and that the said party of the second part shall do and perform the work in accordance therewith. Any increase or dimunition of quantities of any work included in this agreement which shall result from such alterations or modifications shall not affect the prices to be paid for the several items of work, but the prices bid as applied to the quantities of work respectively, resulting upon the final completion thereof as herein provided, shall be in full compensation for the same. No extra work being allowed or paid for except as has been hereinbefore provided.

Payments when made. (R). And the said party of the second part further agrees, that he shall not be entitled to demand or receive payment for any portion of the aforesaid work or materials until the same shall be fully completed, in the manner set forth in this agreement, and each and every one of the stipulations hereinbefore mentioned are complied with and such completion duly certified by the Superintending Engineer or other officer designated by the said Department of Public Parks, whereupon, the parties of the first part, by and through the Comptroller of the City of New York, as directed by Sec. 1, Chap. 447, of the laws of 1876, will pay, and hereby bind themselves and their successors to pay the said party of the second part, in cash, within thirty days from the time of the completion and acceptance of the work, by the said Department of Public Parks, the whole of the moneys accruing to him under this agreement, excepting such sum or sums as may be lawfully retained, under any of the provisions hereinbefore contained for that purpose; but in case the amount payable under this contract be five thousand dollars, or over, payments will be made to the said party of the second part by monthly instal-

Seventy per cent. payments ments of seventy per cent. on the amount of work performed under and in accordance with the provisions and stipulations of this agreement, excepting such sum or sums as may be lawfully retained under any of the provisions of this agreement; provided that nothing herein contained be construed to affect the right hereby reserved of the said Department of Public Parks to reject and withhold payment of the whole or any portion of the aforesaid work, should any of the aforesaid returns or certificates be found or known to be incorrect or inconsistent with the terms of this agreement, or otherwise improperly given, or should any of the work be defective or not built in conformity with this agreement, and provided no monthly payment shall be made on any estimate amounting to less than fifteen hundred dollars.

Water Works, Ancient and Modern.*

BY E. H. D'AVIGDOR.

(*Continued from page* 336.)

The Vanne aqueduct, which is barely completed, is much grander, cost more money, and was intended to supply no less than 107,000 cubic metres, or about 23½ million gallons daily. Several springs near Sens which had been used by the Romans for the supply of that town were purchased by the municipality of Paris. The remains of a Roman aqueduct of about 20 kilometres in length prove that the mediæval legend, purporting to account for the existence of the beautiful fountain in the principal square of Sens, is not worthy of much credit. Once upon a time—says the legend—there was a king of Sens, who, like most of the kings of that period, had an only child, a very beautiful daughter. He promised her hand in marriage to the one among his subjects who should execute the most wonderful work. A wealthy young man appeared as a candidate and offered to cover the town gates with gold, substituting gold chains for the heavy iron ones. A second lover appeared, less wealthy but more ingenious; this one offered to construct a secret passage from the royal country seat of Vareilles into the town. At the expiration of the period allotted to the rivals, the richer had not completed his task, for his wealth was exhausted in vain efforts to cover the huge gates with gold. But the second led the king into the square of Sens, and the princess at a given signal turned a cock which allowed a jet of clear water to rise many feet into the air, to the astonishment of the beholders. The ingenious young man had constructed a conduit from the Vareilles springs into the town, and of course received the princess' hand as a reward, and inherited the kingdom after the death of her father.

Whether this legend be true or not, the springs in question have long been well known. Their level above the sea is 89 metres, the aqueduct has an average falling gradient of 0.13 per 1000, viz., 1 in 10,000 in the conduit, and 0.60 per 1000 in the inverted siphons or lengths under pressure. The three springs, which it was at first hoped would suffice, did not by any means permanently supply as large a quantity of water as the gaugings led one to expect; it was found necessary to bring in the remaining springs of the same group, but as the latter are at a lower level than the former, a pumping machine had to be erected to raise their supply into the aqueduct. This was an awkward expedient, as a portion of the water reaches Paris by gravitation and the rest has to be pumped, so that the expenses of both methods were occurred, and neither of them is fully applied; but the arrangement was the only possible one under the circumstances.

The cross-section of the Vanne aqueduct is quite circular inside, its diameter being 2.14 m.; the masonry is 0.30 m. thick at the springing, reduced to 0.20 m. at the crown and centre of invert, and is of ashlar masonry laid on hydraulic lime mortar. At some few points where a considerable lateral thrust of the ground had to be provided for, the abutments were strengthened. The inner coat of cement extends to 10 centimetres above the theoretical highest water-line, and the extrados of the arch is also covered with cement. The total length of the aqueduct is 137 kilometres, 630 metres—of which 58.5 kilometres are in cutting, 35.5 kilometres in tunnels, 25.8 on arches, and 17.8 in inverted siphons. The length of tunnel and arching is therefore enormous. The siphons consist of two cast-iron pipes 42 inches in diameter.

Instead of the 28½ million gallons expected, only about 17 reach the reservoir at Montrouge, which is by far the grandest work of the sort ever executed. It is at a level of 64 metres above the sea, and covers an area of 38,745 square metres, or about 6½ statute acres, being 287 metres long and 135 metres broad. This reservoir is constructed in the chalk formation and consists of two stories, of which the lower one is 5.50 metres high, and has a capacity of 44 millions of gallons, while the upper story is 3.10 metres high, and has storage for 25 million gallons more.

The two new Paris reservoirs have, therefore, together storage room for nearly 100 million gallons; sufficient for 2½ days' supply for two millions of inhabitants. In this respect they present a splendid example worthy of imitation, and their capacity is, in a proportion to the population, more than eight times as great as that of the Vienna reservoirs. The necessity of increasing the size of the Vienna reservoirs has been repeatedly dwelt upon by the principal authorities, and the work will doubtless soon be undertaken, thus removing the one and only weak point of the water works.

I have already repeatedly alluded to the Vienna Water Works in the course of these papers; I have mentioned the favourable situation of Vienna with respect to water supply and the excellent quality of the water. In the following and concluding pages I will endeavor to give a succinct account of the great works now completed.

The city of Vienna is situated a little south of the right bank of the Danube at the foot of the spurs of the Austrian Alps. The soil on which it is built consists of diluvium from the mountains, composed of limestone, sand, and gravel, with beds of clay in the old or still existing valleys of the numerous streams which, descending from the mountains, find their way into the Danube near Vienna.

The map* shows the general direction and course of the valleys and the line taken by the aqueduct supplying the water-works. The two springs (Kaiserbrunn and Stixenstein), from which the water is now derived, rise at the foot of the Schneeberg mountain (6300 above the sea), respectively east and west of it. This mountain, or rather group of mountains, is composed, like the whole chain, of dolomitic limestone; it is full of fissures, cracks, and caverns. The river Schwarzau, which takes its rise some twelve miles to the northwest of the Schneeberg, skirts the foot of the latter in a long narrow gorge called the Hollenthal (or Hell valley) for about five miles, and emerges into more open country near the favorite watering-place of Reichenau, where its course changes to nearly due east. Here the valley is wider and the river winds from one hillside to the other, occasionally skirting the very foot of steep wooded slopes, sometimes running in wide meadows. At Payerbach the great viaduct of the Sudbahn crosses the valley, and from here to some distance below Gloggnitz the high road and the railway are wedged together on the left bank of the river, mostly in side cutting, and frequently protected by retaining walls. At Stuppach the valley opens still more and the hills become gentler; the valley now turns north-east. At Ternitz the Sirning stream runs into the Schwarzau; it comes from the west of the Schneeberg, and its short but narrow and densely wooded valley, resembling the Trosachs, is occupied by the Stixenstein branch of the aqueduct. From Neunkirchen, a couple of miles further on, the line of the aqueduct leaves the Schwarzau, which it has hitherto continuously followed, the latter runs off to the right, skirting the hills which separate Austria and Hungary, while the conduit keeps to the left along the spurs of the Alps. Between these two ranges lies the plain of Wiener Neustadt, called the Steinfeld (Stonefield), a large basin, perhaps once the bed of a lake, filled with sand and gravel, and intersected by numerous streams, which taking their rise from the lower Alpine spurs, mostly run north-west to the Danube and intersect the general line of the conduit (which is here about N. N. W.) at a very acute angle. The wide flat river beds are crossed by a succession of long and low aqueducts. Below Leobersdorf the conduit and railway once more approach each other, the course of both being due north; the Stonefield is passed and the canal winds around or passes under the spurs of a succession of hills clothed with vineyards and producing the celebrated wines of Voslau and Gumpoldskirchen. The wide, deep, and graceful valley of the popular surburban watering-place of Baden is crossed on an immense aqueduct; then comes a succession of short tunnels and a great bend to the west round the Eichkogl mountain; the deep gorge of Modling is crossed in the middle of the town by several bold arches of 57 feet span; then come more vineyards, tunnels, and rock cuttings, the conduit passes through a swamp at Petersdorf and crosses the wide Liesing valley by means of another immense aqueduct. Another tunnel, another fine range of arches on a curve, and it at last emerges on the ridge at the northern extremity of which is the distributing reservoir of Rosenhugel, from which a splendid view of the city of Vienna, the Danube, and of the hills around is obtained.

The project for supplying the town with water from the springs of Kaiserbrunn and Stixenstein was first started in 1864, and met with innumerable difficulties. It was opposed for many years both on financial and on technical grounds, and no active steps were taken for its execution till towards the end of the year 1868. It would be tedious and uninteresting to recapitulate the different stages of the lengthy debates and wordy quarrels, which at last ended in the contract for the execution of the aqueduct, the three reservoirs, and the pipe-laying being put up to public tender in the summer of 1869. The lowest tender for the whole work was that of Antonio Gabrielli and Company, of Westminster Chambers, London, Contractors to the Admiralty, and this was accepted after a prolonged negotiation and much bargaining. The plans, estimates and quantities having been worked out in great detail by the municipal engineers, Messrs. Junker and Wertheim, the tenders had to be made on the basis of these quantities, and the prices per cube klafter (40.5 cubic feet English) and cube foot (Austrian) thereto affixed. Messrs. Gabrielli offered to execute the whole work at an increase of 12½ per cent. of the schedule, but this apparently handsome addition to the prices, which were supposed to be those usually paid at the time in and near Vienna, proved to be totally insufficient to meet the enormous charges on the work caused by the taxes payable to the Government, the stamp and receipt duties, the many apparently insignificant, but in reality very onerous expenses which had to be borne by the contractor in connexion with the municipal engineering staff; and, finally, the enormous increase in the price of labor and material, which beginning after the termination of the Franco-German war, attained its maximum height in the summer of 1873, during the Vienna International Exhibition. This increase in all prices reached something like 100 per cent. on those established as basis in the schedule, and in many cases exceeded even this figure. Notwithstanding these obstacles, and the difficulties appertaining to the work itself, further the great loss of time and money caused by the thickness of the mains in the towns having been insufficient for the purpose, so that the whole project had to be altered during the execution, the whole aqueduct was completed, and the water brought to Vienna in October, 1873, while the pipe-laying and all the town works were finished in the summer of 1874.

It is not my intention to enter into a description of the mains and of the distribution of water in this paper, which would otherwise reach an inordinate length. Suffice it to mention that the reservoir at Rosenhugel, at which the aqueduct ends, supplies two other distributing reservoirs, those of Schmelz and Wienerberg, by 36 in and 24 in. mains, both these latter being at a lower level, but also situated on hills on the west and south of the town respectively. During the progress of the work it was found that the pressure of the water in the lowest districts was much more than was needed and exposed the pipes to too severe a strain; a fourth reseervoir at a still lower level was therefore erected on the east of the town, which was not included in the contract and not executed by Messrs. Gabrielli. The total capacity of all these reservoirs is barely 4½ million gallons; they contain therefore hardly an eight hours supply for the whole city, and it has been decided, as mentioned already, to increase their dimensions very considerably.

Our description must necessarily be confined to the main aqueduct of which the course has already been traced with the assistance of the map.* It has been mentioned that there is a natural fall throughout, and that inverted siphons are not used. The cross section generally adopted for the conduit is an oblong one approximating to the Roman type. Theoretically it would of course have been more correct to adopt an egg-shaped or circular section, such as those adopted for Paris. For the greatest velocity of the water, and therefore the greatest theoretical economy in construction, is obtained by a section of which the wetted circumference has the smallest proportion to the area, in other words by the circle. But the designers of the Vienna Water Works were quite right not to adopt this profile. There was no occasion to increase the velocity as much as possible; on the contrary, the gradient is so considerable, that the difference of level between the springs of Kaiserbrunn and the reservoir at Rosenhugel (274.9 metres, or about 940 feet) has had to be broken by falls or artificial cataracts, as otherwise the current would have destroyed the inner lining of the conduit. There was, therefore, no necessity to adopt a circular section, nor was the egg-shaped profile required, since the principal advantage of this is, that even with very low-water levels a considerable velocity is kept up; it is therefore more fitted for sewers with very variable discharge than for a conduit in which the water never falls below a certain fixed line. We must also remember, that the sections adopted for the Vienna aqueduct are much easier to construct, and, in fact, cost less money than a circular section, which would have had to be built entirely of ashlar or extremely hard moulded bricks, and must yet have been strengthened by strong abutments in many places to resist the thrust of the ground. Another advantage of the section adopted is, that it is much more accessible for inspection and repairs than the circular one, and that tools and materials can be carried in it with much greater ease and despatch.

(*To be continued.*)

*This map cannot be reproduced.

PERSONAL.

Will the party at Washington, D. C., who some weeks ago sent to this office for a set of drawings of the Newton Hydraulic Dredge for use by a foreign government, please to write again at once. The former letter was sent to Mr. Newton, but he being absent from the city the letter miscarried. Mr. Newton is now in Chicago for a few days, and a communication to this office will reach him.

AMERICAN SCIENTIFIC WORK, FROM AN ENGLISH POINT OF VIEW.

The British Association held its meeting this year at Glasgow, beginning on Sept. 6, with the annual address of its president, Prof. Andrews, of Belfast. On the next day the presidents of the various sections opened the real business, and Sir Wm. Thomson, who has just returned from this country, where he was one of the judges at the Exhibition, devoted a portion of his address to recounting the progress of science in America. He expressed himself as vividly impressed with much that he had seen in Philadelphia and elsewhere, and that what he saw showed the true scientific spirit, devotion and originality, the inventiveness, the patient, persevering thoughtfulness of work, the appreciativeness, and the generous open-mindedness and sympathy from which the great things of science come. These epithets, taken almost verbatim from the report, suffice to indicate the enthusiasm on this subject with which he returned home.

In another place we reproduce some statement which he made in regard to the latest developments in electricity and magnetism. He also alluded in very complimentary terms to Prof. Henry, the rival of Faraday in electro-magnetic discovery; to Peirce the mathematician; to Bache, formerly of the Coast Survey; to our prominent astronomers; and to Commander Belknap, and others who have done much in deep-sea soundings.

He states that he has reasons for confidently expecting that American hydrography will soon supply the data from tidal observations, long ago asked of the English government in vain by a committee of the British Association, by which the amount of the earth's plastic yielding to the distorted influence of sun and moon will be measured. He anticipates that the compass department of the American navy will furnish a fresh marine survey of terrestrial magnetism to supply the navigator with data for correcting his compass without observations on the sun or stars.

His well deserved compliments of our weather reports and the accuracy of "Old Probabilities" we need not repeat; the value of these reports is too well known by all of our readers. After alluding to the U. S. naval observatory and one or two other points he speaks of the Philadelphia Exhibition. "In the U. S. government part of it Professor Hilgard showed me the measuring rods of the United States Coast Survey, with the beautiful mechanical appliances for end measurements, by which the three great base lines of Maine, Long Island and Georgia were measured with about the same accuracy as the most scientific measurers, whether of Europe or America, have attained in comparing two metre or yard measures."

The Patent Museum at Washington and the prevalence of patented inventions at the Exhibition attracted his notice and called forth some comments. He evidently does not agree with those who desire or advocate the common property of inventions, for he says that if Europe does not amend its laws (and England in the opposite direction to that proposed in the bills before the last two sessions of Parliament), America will speedily become the nursery of useful inventions for the world. He then touches upon institutions of learning, very briefly alluding to the oldest—Harvard University, to the Massachusetts Institute of Technology, and the very youngest, but vigorous, John Hopkins University of Baltimore, finally saying that "the stimulus of intercourse with American scientific men left no place in my mind for framing or attempting to frame a report on American science."

CITY YEAR BOOK OF NEW HAVEN, CONN.

To Mr. Charles E. Fowler, City Surveyor of New Haven, we are indebted for the handsomest and most complete city report that it has been our pleasure to examine for many a day.

In addition to the usual matter contained in such reports, some sixty pages is devoted to the Report of the Board of Health, which, with the tables appended, is of much interest to students of sanitary science. The statistical table accompanying the report is classified and arranged on the basis proposed by the International Statistical Congress and adopted by the U. S. Army and Navy Reports; the adoption of the same system by all cities would very much further the study of statistics and the deduction therefrom of important conclusions, conclusions which, coupled with the circumstances of location and an intelligent application of the known principles of sanitary science, would do much to reduce the death-rate from diseases called zymotic, and which are largely, if not entirely, preventible.

It is the duty of Boards of Health, in addition to the one of keeping a city pure and wholesome, the air uncontaminated with the seeds of disease, and free from pernicious odors, the water free from organic contamination, to prepare carefully tables of vital statistics in which all sickness and death with their causes as far as known shall be arranged in a manner admitting of study, to trace these causes, as far as may be, to their source, to secure legislation where necessary, or to report to the Sanitary Engineer, who shall devise such constructions or works as may eradicate the source of the evil. Even with the imperfect reports which have hitherto been made, sanitarians have been able to deduce important results and show a notable decrease in the death rate of those cities which have adopted sanitary works. Yet the benefits which have been realized, although really important, are not a tithe of those which can be made to result when with a correct public education these principles are applied in every household, rich and poor, where most of the abominations originate, but to which the easy-going public scarcely devote a thought. That of 1229 deaths in New Haven during 1875 only 33 should result from "old age," is certainly a comment on modern civilization.

The history of the General Hospital Society of Connecticut, now established fifty years, is of much interest. The specifications for the hospital building are appended in full.

Among the many items which may be of interest we notice the following: A Centennial map of the city on a scale of 100 ft. to the inch, showing every street with their true lines and width, size and shape of all lots, with the location and ground plan of every building in the city; a grade map showing dimensions of all blocks, curb-lines, elevation of each street corner, grade per hundred feet, etc.; a tabulation of all the losses from fires, and their causes; "wires which run in close proximity to tin roofs are badly rusted;" a notice of the usual defects of sewer traps, and the horrors of the tenement-house system; the presence in the water, for two or three weeks of the summer months, "of immense numbers of infusoria, the origin of which is not definitely determined, nor are the means yet discovered by which unpleasant condition of the water can be averted. It is not at all peculiar to the water of Lake Whitney. It is a difficulty which all water companies have had to contend with, and is pretty regularly of annual recurrence." There is no evidence that it is in the least detrimental to health." Filtering and the addition of ice makes the water palatable at such times. There were 2.146 miles of sewers constructed during the year, making the total about 32.5 miles. Vitrified sewer-pipes have not been an entire success, at least in one instance:

The surface of the ground over the sewer in Union street from Fair to Water streets requiring constant repairs by reason of the earth settling away, examinations were made of the sewer, when it was found that the pipe sewer, laid some ten years ago, was crushed in nearly the whole length.

From the City Surveyor's Report the following is of interest:

The heaviest and the most costly work was the building of the sewer in Winthrop and Whalley avenues, the main outlet for the western and northwestern section of the city, including those streets now or hereafter laid out in the Beaver Pond Section, so called. The cutting for this sewer was from twenty-two to thirty feet in depth, and for about half of the way was below the spring water level. Considerable difficulty was experienced from quicksands, which rendered necessary the utmost care in the bracing and sheeting of the sides of the trench.

At the intersection of Sherman and Winthrop avenues with Whalley avenue to prevent excessive cutting, the curves and branches for the lateral sewers were brought into sewer wells at a moderate depth. The sewage then falls perpendicularly about thirteen feet, striking in water at the bottom of the well, and is then conveyed by a conduit into ths sewer. On this sewer the branches for house connections are carried up perpendicularly from the side of the sewer to a point about twelve or fourteen feet below the street surface with a Y branch and quarter bend at the top.

The average contract price per foot of the sewers built during 1875 was as follows:

SIZE.	MATERIAL.	AVERAGE CONTRACT PRICE PER FOOT
54 inches	Brick	$12 00
48 "	Brick	10 00
36 "	Brick	4 45
30 "	Brick, 8 in. Invert	2 68
30 "	Brick, 4 in. "	2 25
24 "	Brick, 8 in. "	2 72
24 "	Brick, 4 in. "	2 05
18 "	Cement Pipe	2 43
15 "	Cement Pipe	2 03
12 "	Cement Pipe	1 62

The subject of Street Pavements we give in full:

On January 1, 1875, there were 11.575 miles of paved streets within the limits of the city. During the year there have been added 0.887 miles of Telford pavement, making a total of 12.462 miles, which is divided among the different kinds as follows: Telford, 8.559 miles; Belgian, 2.228 miles; Wood, .558 miles; Concrete, .491 miles; McAdam, .322 miles; Belgian and Telford mixed, .162 miles; Cobble, .142 miles; total, 12.462 miles.

That no other kind of street pavement has been constructed or ordered by the Court of Common Council is an evidence of the favor in which the Telford pavement is held by our citizens, and that its popularity as the best and most economical one remains undiminished.

As there have been many inquiries concerning the manner of construction of this particular kind of pavement, I will submit briefly the general features of the specifications, showing what is required of the contractors. Upon each side of the street is placed curbing of the best quality of North River Blue stone, sixteen inches in width, not less than three feet in length, nor less than four inches in thickness, set to the required line and grade, and at all intersecting streets the corners turned with curb cut to a radius of six feet, except in those cases where a catch-basin exists, the granite head of which is cut to the same radius. The roadway between the curb-lines is excavated to the proper depth for receiving the stone. The first layer consists of broken and irregular shaped pieces of "trap rock," such as may be procured in large quantities at the base of East or West Rocks, not measuring more than twelve inches in length. The stones are set by hand in the form of a close, firm pavement, on their broadest edges, and lengthwise across the street. The average thickness of this layer in the centre is seventeen inches, and on the sides five inches. Upon the first layer is placed a second one of small, broken pieces of stone, procured as above described, filling in and levelling up all the interstices and irregularities of the first layer. The average thickness of this layer is four inches.

Upon each side of the roadway and next to the curbstones, is placed a gutter stone of the best quality of North River blue stone, twelve inches in width, not less than three feet in length, and not less than three inches in thickness, firmly bedded in sand or gravel. The edge of the gutter stone next to the curbstone, is placed eight inches, or an average of eight inches, below the top of the curbstone, with the outer edge one inch higher. Next to the gutter stone is placed curbing of North River blue stone, not less than twelve inches in width, three feet in length, nor three inches in thickness, set true to a line and grade, and parallel to the sixteen inch curbstone. The top of this outer curb is placed at the same height as the outer edge of the gutter stone. Upon the completion of the gutters and the two layers of stone, as before described, the whole is then thoroughly rolled with the steam road roller, owned by the city. This roller is one of Aveling and Porter's make, weighing about seventeen tons when in working order, and rolls a width of six feet. After the foundation has been thoroughly rolled, a layer of crushed stone is then placed on the roadway, averaging four inches in thickness. These stones are procured at the stone crushing works owned by the city, and located near West Rock. The size of the stone used in this layer is that which comes from the screens with circular openings, two and a half inches in diameter. This layer of stone is thoroughly sprinkled or wet down with water, and rolled with the roller after its completion.

A layer of loam one inch in thickness is then spread over the crushed stone for a binding material. A top dressing of fine crushed stone or "screenings," as it is called, two inches in thickness then follows, and the whole then thoroughly sprinkled and rolled. The "screenings" is the dust and fine crushed stone which comes from the screens at the crusher through circular openings one inch in diameter. This, with the binding material, soon forms a cement which makes a hard smooth crust for the surface of the roadway. After all rolling is done, the gutter stones are relaid and all

joints filled with cement mortar. The crossings, of flagging and cobble stone or Belgian blocks, are not put down until the Telford pavement is completed.

In those streets where there is a horse railroad track, the space between the rails is laid with Belgian blocks. The crown given to the surface of the roadway is to place the grade for the top of the crushed stone at the centre of the roadway, not including the "screenings," at one-half as many inches above the grade of the gutter as there are feet from the curbstone to the centre of the roadway.

The cost of the Telford pavement averaged $1.32½ per sq. yd.

There are other special reports of more or less general interest.

FROM an English paper we extract the following notes:

THE British Association held its annual session in Glasgow in the early part of September. The president for the year is Prof. Andrews, of Belfast, a distinguished chemist, and on some important points an "anti- Tyndallite." His address was a review of the progress recently made in the field of scientific research. After touching upon the Polar Expedition, the transit of Venus, the approach to greater accuracy in the estimate of the earth's distance from the sun, the nature and origin of ærolites, and sundry other investigations, he enlarged on the utility of practical science and its claims on the study and the gratitude of the nation. It ought, as he contends, to have a distinct place in the curriculum of our universities, while in addition there should be established schools of practical science in alliance with Oxford and Cambridge, in which literature, while not neglected, should assume a secondary place.

SIR WILLIAM THOMPSON, in his address in the physical section of the British Association, created almost as great an excitement as when he advanced his meteoric theory of the origin of life in 1871. The subject he undertook to discuss was the fluid or solid nature of the earth's kernel; in other words, whether the earth is or is not a spheroidal shell filled with liquid. He abandons the old belief, and maintains that it is simply impossible that any considerable portion of the interior of the earth can be in the state of molten fluid. The spaces in the volcanic regions which contains fluid are small, and the earth he declares, therefore, to be a solid, the grounds of his belief appearing even to a "lay" reader to have great force,

Other points in his paper are of wider interest. In regard to electricity he reported various remarkable advances. In the Philadelphia Exhibition he saw an electric telephone, which sounded four messages simultaneously on the Morse cord, and which, with improvements of detail, may be made to sound four times four. He also saw Edison's automatic telegraph deliver 1,015 words in fifty-seven seconds. Last, and most wonderful of all, he mentioned a development of electricity for which we are indebted to a young Scotchma, Mr. Graham Bell, now of Montreal and Boston. He has made a telegraph wire convey vocal sounds. Sir William Thompson heard it speak. First of all came the familiar words—foreshadowing, perhaps, the inventor's eager curiosity as to the general application, and the ultimatate success of his invention, "To be, or not to be?" "Aye, there's the rub," and following these came paragraphs taken at random from the New York papers. "All this," says Sir William, "my own ears heard spoken to me with unmistakable distinctness by the thin circular disc armature of just such another little electro-magnet as this which I hold in my hand. The words were shouted with a clear and loud voice by my colleague judge, Prof. Watson, at the far end of the line, holding his mouth close to a stretched membrane, such as you see before you here, carrying a little piece of soft iron, which was thus made to perform in the neighborhood of an electro-magnet in circuit with the line motions proportioned to the sonorific motions of the air. Who can but admire the hardihood of invention which devised such very slight means to realize the mathematical conception that, if electricity is to convey all the delicacies of quality which distinguish articulate speech, the strength of its current must vary continuously, and, as nearly as may be, in simple proportion to the velocity of a particle of air engaged in constituting the sound."

WE print the following editorial from the N. O. *Times* of Oct. 19. as being the freshest news of the operations at the head of the passes, and also as bearing on views expressed in ENGINEERING NEWS of Sept. 23, to which the reader is referred. Two immaterial paragraphs are omitted:

The Jetty Works at the Head of the Passes.

The protest signed by a number of the Branch Pilots, and addressed to members of the Cotton Exchange and other commercial bodies, in relation to the work which, Captain Eads has thought necessary to put down at Southwest Pass, has provoked hasty judgment and harsh criticism upon Captain Eads in several of the city papers. * * * It is well known that Capt. Eads is constructing works at the head of the Passes to concentrate and increase the flow of water into the channel which he is dredging through the hard bar at the head of South Pass. While the permanent works relating wholly to South Pass head are incomplete and in process of construction, the volume of water into Southwest Pass is greatly increased, and in consequence Southwest Pass at its head is rapidly deepening and enlarging. The water at the head of this Pass was already thirty feet deep, which is as great a depth as will be required under any circumstances in any of the Passes The engineers are putting across the head of Southwest Pass a sill of matresses from eighteen inches to two and a half feet thick simply to prevent the bottom of the channel there from scouring deeper than thirty feet for the present, until the completion of the works at South Pass head, and the restoration of the normal volume of water through that Pass.

* * * * * * *

The piles driven in Southwest Pass are simply to aid in putting down the sill in the bottom of the channel. One side of the Pass is left open until the sill is down in the other half, when the piles will be pulled up and removed so that there will be a clear channel thirty feet deep where the sills have been laid, and when the sill is clear across all obstructions will be removed from the whole Pass. In the mean time, lights are on the piles, guards are stationed at night to warn vessels, and every precaution used to prevent accident. No mud is being dumped in Southwest Pass, and but little has ever been put there. The work of dredging, though with but one boat as yet, is progressing very satisfactorily. About seven hundred and fifty cubic yards are removed daily, and a clear under-water canal has been cut through the bar, making a channel seventy feet wide in the lower part and forty in the upper, and clear nineteen feet deep in low tide. This channel is now being widened and deepened, and thus far, after more than a month's test, no part of it is disposed to fill up, but, on the contrary, is cutting out steadily.

The Centennial Exhibition.

BY C. J. MOORE, C. E.

[Written for Engineering News]

Bearing in mind the meagre appropriation made by Congress and the delay in making the same, the display by our government must be considered creditable—in fact, in some departments, very successful. The great want is an absence of catalogues, the appropriations being entirely inadequate to allow of such being printed, consequently, in examining the exhibits of the various departments, one has no further assistance beyond the courtesy of the officers and gentlemen in charge than can be gathered from a simple *index* to a catalogue in the Ordnance department, a list of publications of the Engineer department, a brief catalogue of articles relating to the Wheeler explorations, a very short memoir on ancient tribes, pottery, and cliff dwellings in Arizona in the Hayden Expedition, and the general documents of the Land Office.

On turning to the official catalogue issued by the U. S. Centennial Commission, one finds very brief, incomplete and unsatisfactory remarks, and nothing whatever explanatory of the Treasury exhibits which, bear in mind, include those of the Coast Survey and Lighthouse department—most interesting sections. The Navy department have, however, just issued a catalogue of its exhibits, printed in English, French and German, side by side on a three-column page, in a handsome quarto of 64 pp, containing full descriptions of all the objects shown by the department.

The building is in the form of a Latin cross, 504 feet long by 360 feet wide and 50 feet high, with two tiers of windows, and in the intersection of the centre lines of nave and transept is placed a well arranged trophy of the various natural productions of the country, consisting of corn, tobacco, wine, wheat,oats, cotton, marble, iron and lead ores at the base, surmounted by a complete section of the 44th vein of the well known Plank Ridge Colliery anthracite, measuring feet square and towering away up into the roof of the trophy is ornamented by crossed picks on each of its four sides. The floor area of the building is 102,840 sq. ft.

Entering at the west end one first comes, on the right, to the exhibits of the Geological and Geographical Survey of the Territories, part done under Prof. Hayden, and part by Lieut. Powell, U. S. E., the whole in charge of Mr. E. A. Barber who accompanied Prof. Hayden in Colorado and Arizona. Those chiefly of interest to engineers consist of photographs, plans (both by hand and lithographed) beautiful water color drawings by Moran, and models in paper mache. These include a model of the Yellowstone National Park in the northwest corner of Wyoming, on a hor. scale of 2 miles = 1 inch and vertical scale twice the size, and a photograph of the same; a model of a ruined watch tower on the Rio McElmo in Colorado; three models of the Elk mountain region in Colorado both geologically colored, but one taking apart in sections showing the supposed courses of the various strata under ground; the scales are each south of those of the Rio McElmo town. There is also a photograph of the Elk mountains model shown, and some excellent topographical views sketched in India ink outline, and a long section showing very clearly the peculiarities of the geological formation. Similar outline sketches are shown of the Sawatch range, and the Pikes Peak group of mountains in Southern Colorado; also a most truthful sepia and India ink drawing of about 120 miles of the Rocky mountains as seen from a point 30 miles east of their base, Denver City being in the immediate foreground; indeed the great truthfulness of this and of all these topographical sketches is remarkable; the writer well remembers the two peculiar elevated table lands at each side of the Clam Creek Canyon, 15 miles west of Denver and is familiar with most of these scenes. This sketch measures 9 feet long by 7 feet breadth. There is also a geological section of Middle Park.

A well colored and accurate general geological map of Southern and Western Colorado on a scale of 4 miles to 1 inch, geological map (uncolored) of the Eastern Bar of the Rocky Mountains, for a distance corresponding to the sepia sketch mentioned above, a map of Lake Henry and the surrounding district, of Colorado springs and neighborhood (geologically indicated in red line shading), the sources of Snake River; three lithographic maps of Southwest Colorado (uncolored) showing the contours for every 200 feet of vertical height on a scale of four miles to the inch, a sketch of the primary and secondary triangulation of 1875 over the district shown, finished on the general geological map above referred to, viz: from 40° 20′ to 37° 50′ latitude, and 104° 50′ to 107° 10′ longitude, and some gelogical sections along the eastern base of the "Rockies." All these are the exhibits of Hayden's surveys.

Lieutenant Powell's two principal exhibits are large models in relief, on a horizontal scale of 2 miles to the inch, and vertical scale of 5000 feet to the inch; of Niagara, Yosemite and the great Colorado canyons, compared all on the same scale and at their respective elevations above sea level; the portion showing the Colorado canyon also showing the cliffs of Southern Utah. One model is colored to show the geology, from which we find, rather to our surprise, that about seven-eighths the area of that portion of Arizona shown, is of the carboniferous series, and the other model is colored to show the timber, irrigable and pasture lands, and the roads and trails, from which we find that timber occupies about one-eighth and pasture seven-eighths in the Arizona district; there is no irrigable land therein and only a few thousand acres in Southern Utah. The Yosemite valley with its 2000 and 3000 feet altitudes seems dwarfed beside the 5000 and 6000 feet for mile after mile of the Great Colorado Canyon, and the Niagara gorge literally seems "nowhere;" it is scarcely perceptible. The two other models in relief illustrating Powell's surveys are of the Henry mountain region in Southern Utah on an equal vertical and horizontal scale of two miles to the inch; the one showing the geology as at present existing, the other showing what the geology was under the influence of displacement alone, and unaffected by the degradation which has altered it to its present condition. These interesting and instructive models together with two atlases of the geology of the Uinta mountains, Utah, by Lieut. Powell, a plane table covered with canvass, having a handy pocket at one side for the Alidade, and five preliminary maps showing

the transcript of field notes taken on the plane table, complete the exhibits of the geological surveys of special interest to engineers.

A large map of the whole U. S. on a scale of 16 miles to the inch, prepared under Prof. Hayden's direction, and showing by colors all the contours 1000 feet apart, vertically, should not be omitted; from it we see that fully three-fourths of all the elevations above 13,000 feet are in the new state of Colorado. Now, interesting as all this exhibit is to the casual visitor, with its many and large photographic transparencies of Indians, their manners, customs, dwellings and surroundings, the maps described, beautiful water-colors of the Yellowstone region and other mountain districts, the models of animal shaped mounds in Wisconsin, ancient cliff dwellings and fortifications in Arizona, Indian weapons, tools, ancient stone arrows and arrow heads, etc., etc.—it is not entirely satisfactory to the engineer who wants to know how and at what expense was all this information obtained? what was the organization of the parties? what was their equipment? what the special duties of each member? and, perhaps most interesting, what were the scientific instruments (though they are shown in Lieut. Wheeler's exhibits elsewhere) used, and what results did they give in such trying practice? Doubtless the answers to most of these questions may be found somewhere among the archives at Washington, but it is scarcely exacting to expect that one should be able to answer all such questions from a careful inspection of the exhibits in a collection of the complete character evidently intended in the one under notice,—perhaps shortness of funds is the reason for this deficiency.

Passing by the Archæological, Indian and Educational exhibits we must pause at the large collection of models (some 5,000 in number) from the Patent Office. These are grouped together under the heads of Agriculture, Harvesters, Mills and Presses, Architecture, Civil Engineering, Railway, Navigation, Metallurgy, Metalworking. Wood-working, Steam, Hydraulics, Pneumatics, Mechanical movements, Hoisting, Horsepowers, Journals and bearings, Vehicles, Firearms, Textile, Printing and Stationery, Paper, Stone, Clay, Glass, Leather, Heat, Light, Electricity, Household Chemistry, Gas, Ice, and Fine Arts. Who is responsible for the careless manner in which these are—can we say arranged?—we are unable to say, but from this carelessness the value such a collection might have had is entirely wanting.

If certain subjects were decided upon to be illustrated by Patent Office models, these models should at least have been carefully selected and arranged so as to show by proper position in consecutive order and by brief descriptive memoranda, the progress made in the art, in manufacture, or industry from the time of the first patent issued in that class to the latest illustrated. As it is, "higgledy-piggledy" best expresses both selection and arrangement, models of good and practical improvements seem to have dropped into the collection more by good luck than good management.

Adjoining these on the South wall of the building is the exhibits of the General Land Office consisting of separate maps showing the state of the surveys up to the close of last year in each of the States and Territories over which the office has jurisdiction, viz., Florida, Louisiana, Indian Territory, Kansas, Nebraska, Minnesota, Dakota, Wyoming, Colorado, New Mexico, Arizona, Utah, Montana, Idaho, Nevada, California, Oregon, and Washington, and one general map on a scale of 1 inch. There is besides a large map measuring 22x17 ft., lately finished (by hand), and hung up last week, showing on a scale of 10 miles to 1 inch the progress of the public land surveys to date, and if one inquires at the office in the building he is courteously supplied with various documents relating to the location and assignment of Bounty land warrants, etc.

Colleges and Engineering Instruments.

In the article on "Colleges and Engineering Instruments" in No. 41 of ENGINEERING NEWS, the judgement passed upon the inferior class of surveying instruments used for the purposes of tuition in our educational institutions, would have applied with more force, five years since than at present.

Some of the credit of this desirable change can be laid to the indirect influence of the Centennial Exhibition, as this almost universal "setting of their houses in order" by the various college authorities, was somewhat due to the desire to place their institutions in as favorable a light as possible before the European engineers and scientists who were expected to visit us during the Centennial year.

During the last few years, almost all of our leading Institutes and many of the so-called "smaller colleges," have procured instruments of the most approved modern construction, and the line of instruments now possessed by institutions of such standing as the University of Pennsylvania, Princeton College of New Jersey, the Troy Rensselaer Polytechnic, Mass. Institute of Technology, Dartmouth College, and Columbia College of New York City, almost leaves nothing to be desired. As manufacturers we speak rather feelingly (financially) in this matter, as this general overhauling and removing has been of advantage to us in the general depression of all engineering business,—as we have furnished in the last few years fifteen of these institutes with setts of field instruments, notably among these being the Polytechnic, University of Penn., Dartmouth College, Princeton College and the University of California. We have also lately furnished the Imperial College of Japan at Tokio with another full outfit.

One of the indirect advantages of the Centennial Exhibition has been the number of foreign Civil and Mining engineers who have taken the opportunity to cross the ocean and visit this country, and the number of this class of visitors has exceeded the expectations of the most sanguine,—the entries at the rooms of the Society of Civil and Mining Engineers in the main Exhibition building, and at the room of the Franklin Institute in Machinery hall, bear witness to this, and we ourselves have been favored with the visits of over three hundred of this class at our exhibit and manufactory. We found, in conversation with these foreign visitors, that besides seeing the Exhibition, the majority of them proposed making flying trips of greater or less extent through the country; some contenting themselves with visiting merely the neighboring cities of New York, Boston, Baltimore, Washington, etc., others, like Prof. Rupka of Germany, and Levasseur of France, making trips of several months' duration, and reaching from Canada to California. As to the number of home surveyors and engineers who are "doing" the Centennial, some slight idea may be formed from the fact, that at present at our own special exhibit, the daily number of this class of visitors averages 150, and that we have distributed over 1500 copies of our pamphlet, "Remarks on Engineers' Surveying Instruments," to engineers at the Exhibition.

To return, however, to the article on Colleges, etc., that prompted this communication: The wooden "plane table" to which the writer takes exception, is not intended, we think, for precise field work, but merely as a "resting drawing board" to allow of "filling in" topographical work in the field, at least we judge so from the fact that some of the same class have been desired of us. The article also refers to the importation of foreign instruments by teachers for the purposes of tuition; by referring to the U. S. Custom House entries it will be found that the importation of this class of goods has of late years almost entirely ceased, the bulk of imports of this class being made up of Swiss and French draughting instruments, and of engineers' supplies, (tapes, drawing vellum, etc.) In fact, the American engineer does not take kindly to the European form of Engineering instruments, and will not use them if he can otherwise help himself; a case in point occurred lately in this vicinity, where one of the trustees of a scientific institution, while travelling in Europe, purchased a French theodolite of the regular orthodox French and German type, one with inverting telescope, exposed horizontal limb graduation, trussed legs to tripod head, and with wood enough in the legs and tripod head to make a comfortable load for one man to carry. This instrument he made a present of to the institution on his return home, but to his surprise and disgust, after one trial in the field the professor and students who had been accustomed to the more compact American transit, unanimously came to the conclusion that a glass case would be the most suitable place for it, and although sadly in want of field instruments could not be induced to use it again.

Speaking of tripods, the Sept. 30th number of ENGINEERING NEWS gave the description of a new method of attaching Surveying instruments to their tripods. We would call the attention of the makers to a few facts in reference to this method that has come under our notice. The mechanical method employed, commonly called the "three segment method," was first used in hose couplings as a substitute for the screw, and was by the writer of this tried on instrument tripods almost in a similar manner to the mode described. This was about twelve years since. After some trials the following defects were discovered, which led to the abandonment of this method. First, the inclines of the projections were required to be steeper than the ordinary pitch of a screw, (properly these inclines ought not to have more than one-twelfth (1-12) of a whole turn, nor more than a one-half (½) inch pitch), and with such a steep incline as this, they were apt (even when new and ungrooved by wear) to shake loose by comparatively slight jarring. The projections on the cap and tripod head would in a short time wear grooves in each other, and this happened the more rapidly if the surfaces were not kept very clean, and this grooving leads to the worse defect of not allowing the effective joining of the instrument to the tripod. If sufficient force was employed to effect this, the unclamping and taking off the tripod could not be accomplished by mere hand power, but hammering with a mallet was required. Heller & Brightly.

Philadelphia, October 10th, 1876.

NOTES.

HOLLAND is to have an International Exhibition in 1877. Next!

It is proposed to erect a $4,000 County Hospital in Fresno, California.

Fresno, Cal., is soon to be supplied with an abundance of fresh water.

The new Castle Garden, N. Y. City, will be ready for occupancy next week.

Marshall county, Iowa, is to vote this fall on the proposition to build a $50,000 jail.

THE Sutro tunnel is now in 14,500 feet, with quartz and clay seams in the headings.

For want of funds the Department of Public Works, N. Y. City, has suspended work on Tompkins Square.

The whole of the ruins of the Tuileries are to disappear before the opening of the French Universal Exhibition.

Santa Cruz, California, has water works of its own, with pressure sufficient to send a stream of water a hundred feet in the air.

The cactus plant is being utilized in California, it being crushed into pulp for making paper and sent east at the rate of twenty tons per week.

Horse-cars are making great progress in France. Marseilles was the first city to employ them extensively. They traverse its leading thoroughfares.

A new water main, 20 inches in diameter, has just been laid along Wall street, New York City, supplying a need for which the insurance companies have often applied.

The Canadian Government is negotiating with the Board of Water Commissioners for the supply of water for the Parliament buildings; the annual cost will be something like $10,000

The Middleton Sewer, the largest sewer ever built in Newport, R. I., and costing about $13,000, commenced Sept. 26, has just been completed, the work being done by the city under the supervision of Street Commissioner Jeremiah Peabody.

The King of Belgium, when opening the Geographical Congress at Brussels, proposed to lay out roads from certain African seaports to the country between the Tanganyika and the Nyanza lakes for the purpose of further explorations.

The Champ de Mars has been quite closed for the works of the Paris Exposition of 1878. The great undertaking is exclusively in the hands of the public administration, all the expenses of buildings, etc., being supported by the public exchequer.

The bridge of the Boston Water Works over Charles river is supported by the largest arch, except one, in the world. It measures 134 feet in length, and 65 feet from the keystone to the water. The weight at the center is 480 pounds to the square inch. It was constructed solely to carry Sudbury river to the other side, and will cost, when completed, $200, 000.

There are 119 life-saving stations on our coast from Maine to Florida, thirty on the lakes, and eight on the Pacific, employing 1,100 men. The coasts of New Jersey, Long Island, and North Carolina are the most dangerous. Each keeper gets $200 a year and they have saved 3,168 lives in the last four years.

The contract for the facing of the dam and finishing the gate houses of the Hempstead Reservoir was awarded by the Brooklyn Commissioner of City Works to John Brady for $22,799.60. Kingsley & Keeney, who claim a right under their contract to do all that remains to be done on the reservoir, have sent a protest to the Mayor.

The Common Council of the City of Providence, R. I., on the 19 inst, passed an ordinance to establish a Board of Water Commissioners, consisting of three persons, at a salary of $1,200 each, and who are to have the control and management of the City Water Works. The ordinance was opposed by the Mayor. For full text of ordinance see Providence *Journal*, of Oct. 21.

The buildings of the Paris Exhibition of 1878 will cover a space of 1,350,000 square yards. They are to be of iron filled in with brick work, and will have the form of a Pythagorean table; i. e., if passed through in one direction the similar productions of different countries may be inspected, while if crossed in the other direction the various products of any one country may be passed in review.

The London *Times* says the desire to construct the largest single roof in the world was achieved in the roof of the Midland railway station at St. Pancras, which now possesses that distinction, having eclipsed the roof of the Imperial riding school at Moscow by a few feet, the span of the former being 240 feet and that of the latter 235 feet. The roof to cover the large new station at St. Enoch square for the Glasgow Union railway has a span of 198 feet and a length of 518 feet. The roof af the new joint station of the Midland, the Great Northern and the Manchester, Sheffield and Lincolnshire railways has a span of 210 feet.

The following Boston sewer contracts have been awarded: Myrtle street and Chauncy place, West Roxbury, to Daniel B. Kay; Clifford street, Boston Highlands, to Collins & Tinkham; Lamartine street, West Roxbury, to John Kelly; Harris avenue, West Roxbury to T. F. Kelley; Byron and Ellsworth courts, West Roxbury, to Dennis O'Connell; Wyoming street, Boston Highlands, to Sanborn & Stevens; Adams and Dix streets, Dorchester District, and Alberton and Roanoke streets and Greenough avenue, West Roxbury, to W. R. and C. J. Connolly; Warwick and Marble streets, Boston Highlands, to John Callahan; Hereford street, city proper, and Centre street, West Roxbury, to O. Trefetheren.

Four projects are on hand for crossing the East and North Rivers. These are, the Brooklyn bridge, 1,600 feet clear span; the Poughkeepsie bridge, 1,630 feet; the Blackwell's Island bridge, two spans, 1,270 feet; and the Hudson River tunnel, 10,000 feet long. The cost of the Brooklyn bridge will be over $13,000,000, and the Hudson River tunnel about $15,000,000, according to the estimate. The company has $10,000,000 capital. The suspension bridge over the Hudson will have of entire length, 2,230 feet; distance between centres of towers, 1,680 feet; clear span, 1,630 feet; clear height above water, 165 feet; railway grade above water, 190 feet; height of towers above water, 340 feet. The towers are to be wrought iron, with granite foundation piers; the cables and backstays of the best steel, in links and pins, not wires. The rest of the work is to be wrought iron of the best quality. The anchorage and foundations are in solid rock. The bridge does not encroach upon the water-way of the river at all, and can never for a moment interfere with navigation, either during its construction or afterward. The site is at Anthony's Nose, four miles above Peekskill, which is the best crossing between New York and Albany.

The St. Louis *Republican* says: Mr. George A. Fairchild, of the United States Coast Survey, is engaged in a transcontinental triangulation. The object of this survey is to determine the length of the thirty-ninth parallel from the Atlantic to the Pacific coast, and which will connect the surveys of the two coast lines. It will also furnish additional data for determining the shape of the earth's surface, and then all these triangular points will give accurate data for the surveys of the different States. This will be the longest triangulation ever made in any country, the distance being some three thousand miles. Eleven measurements of degrees, for determination of the curvature of the earth's surface, have been made by other countries, of which nine only belong to the present century. The present triangulation across the continent was commenced several years ago. On the Atlantic coast the starting point was on the Chesapeake, and the triangulation is completed to Harper's Ferry, and from the latter point a special reconnaisance has been made to the Ohio river, striking it on the thirty-ninth parallel. Coming east from the Pacific coast, Professor Davidson, of the Coast Survey, is in charge of the triangulation from a point above San Francisco to the Sierra Nevada. Some three or four years ago the survey was started at St. Louis, working both ways to join the work from the east and west.

Railway News.

Central City, Col., will soon have an adequate water-supply, The mains will be completed in thirty days.

The Chicago Burlington & Quincy Company has purchased the Rockford, Rock Island & St. Louis Railway.

The Dumbarton railroad engineers are hard at work in the mountains above Lexington, Santa Clara Co., Cal.

A narrow gauge railroad between Bellevue and Cascade, Iowa, is being talked up by the citizens along the route.

Some two hundred men are at work on the railroad bridge at Watsonville, California. The estimated cost is $23,000.

A company has been organized in California to build a railway from Los Angelos to San Diego, 140 miles. Capital stock, $5,600,000.

There is said to be a projected 7,974 miles of narrow-gauge railway in America, and a completed length of 2,687 miles. There are 88 companies in operation.

Palestine is to have a railroad, and the cry will soon be: "All aboard for Jerusalem. Passengers for Moab and the Dead Sea will please remain in the forward car."

A SURVEY is soon to be made for a narrow gauge road from Boston to Providence, *via* West Roxbury, Dedham, Norwood, Wrentham, Attleborough, and Valley Falls.

The great quantities of railroad ties accumulating at the new depot of the Southern Pacific railroad at Los Angeles, Cal., would suggest a vigorous prosecution of railroad building shortly.

THE competition between the Boston, Revere Beach & Lynn (narrow-gauge) and the Eastern (standard gauge) Railroads has brought fares down, between Lynn and Boston, from 30 cts. to 10 cts.

THE North Pacific Coast Railway (narrow gauge) is constructing a trestle bridge across Brown's Canyon, two miles northwest from Freestone, Sonoma county, Cal., 135 ft. in height and 600 ft. long.

The Secretary of State of Illinois has issued a certificate of organization to the Beach Improved Railway Manufacturing Company, of Chicago; capital $100,000. The company will manufacture improved car-wheels.

The Southern Pacific railroad engineers are surveying the route of the road from Goshen toward Mussel Slough donbtless with a view of making the main line connection from the Salinas Valley to the San Joaquin.

THE new iron bridge of the Delaware, Lackawana & Western, spanning the Hackensack River westward from the approach to the Neubergen Hill tunnel, N. J., is completed at a cost of $130,000. It is the first iron railway bridge across this river.

The contract for grading the first six miles of the Lockport and Buffalo road has been let to Michael Lalley, of Lockport. This road is to be 13 miles in length extending from Lockport to a connection with the Niagara Falls Branch of the Erie, at Tonawanda, N. Y.

Macdonald, Kane & Co. have definitely declined the acceptance of the contract of section 15 of the Canada Pacific Railway; Messrs. Charlton & Whitehead, who come next in order, have now the opportunity of taking the work, on producing proper securities. The opinion, however, prevails that the work will be re-advertised.

A SURVEYING party started out from Chicago, Wednesday of this week, under the auspices of the Chicago, Pekin & Southwestern R. R., to survey the old Decatur & State Line R. R., with the probable object of building this long projected line, and thus giving a new southern and southwestern feeder to Chicago.

THE Omaha *Republican* of Oct. 14 says that on that date work was to begin on the Omaha and Republican Valley Railroad, from the Union Pacific to the east bank of the Platte river. As soon as this portion of the work is completed, the pile bridge across the Platte, 2,100 ft. long, will be constructed, and track-laying will commence from the west bank through Saunders county.

The San Diego *World* says: The people of San Bernardino propose to build a railroad to Colton, at a probable cost of $20,000 to $55,000, and to continue it to Mound City, so that when the Southern Pacific Railroad has completed its line between Mojave Station and the San Gregorio Pass, it may be induced to connect at San Bernardino.

Articles of incorporation of the Los Angeles and San Diego Railroad Company were filed October 9th. The incorporators, viz.: Mark Hopkins, David D. Colton, E. H. Miller, Jr., Nicholas T. Smith and B. B. Redding form the corporation for the purpose of constructing and operating a railroad and telegraph line from Los Angeles to Anaheim, thence to San Diego, a distance of 140 miles. The first Directors are Leland Stanford, D. D. Colton, Mark Hopkins, Charles Crocker and B. B. Redding. The capital stock is $5,600,000, divided into 56,000 shares.

The *Railway Age* says that 14,743 miles of line, belonging to 37 British railway companies, have cost £542,010,204 or over $2,700,000,000. This would give an average cost of £36,763.22 or about $180,000 per mile. This sum being so large, we infer represents the total expenditure on the roads to date. The average dividend was 4 7-10 per cent. The highest dividend of any company was 12 per cent., and the lowest ¾ of 1 per cent. As a whole this is an excellent showing, considering the price of capital in England, and far better than the average of American roads.

The scheme for extending the Denver and Rio Grande Railway into the San Luis Valley has at last taken tangible shape. Proposals are to be received on Oct. 27, for grading the road-bed from La Veta to the summit of Sangre de Cristo range, about 15 miles, thence down the Sangre de Cristo Creek to the mouth of Wagon Creek, about 10 miles, thence to a point near Fort Garland, about 10 miles. Work is to commence in 10 days after signing the contract, and to be completed by May 1, 1877. As is usual with railway contracts, the time between the publication of the notice and the opening of the bids is too short to allow our publishing the notice; and, indeed, such notices are of little use other than to fulfill the law, as the letting of the contract is apt to be foreordained. The construction of this piece of road will give the Denver and Rio Grande road entire control of the trade of the San Juan country for the present. The road will probably branch at the Rio Grande River, one track going up toward Del Norte, and another down toward New Mexico.

The Petaluma *Argus* publishes the annexed: Superintendent Bean informs us that the freight and passenger business on the San Francisco and North Pacific Railroad at present is fully as large as it has been at this season of the year at any time since the road was built. Considerable repairing is going on on the main line in the way of levelling and ballasting the track, and new culverts are being put in in several places. The grading on the Guerneville branch is completed, and workmen are engaged in constructing bridges, trestle-work and culverts on the section between Korbel's and Guerneville, which is about two and one-half miles in length. The track will be laid as soon as the iron arrives, which was shipped from New York about two months ago. The expense of constructing the branch road has been very heavy, parts of it having cost over $75,000 per mile. The terminus will be in one of the most lovely timbered districts in the State, and millions of feet of lumber will be shipped over the road within the next few years, also many thousand cords of fuel.

Museum of Mineralogy.

The following circular has been issued by the Centennial Committee of the American Institute of Mining Engineers,

The American Institute of Mining Engineers has received from foreign governments, commissioners and private exhibitors, numerous donations of mineral and metallurgical products, now on exhibition in the Centennial Buildings. After the close of the Exhibition these collections will be placed in one of the saloons of Memorial Hall, generously placed at the disposal of the Institute by the trustees of the Pennsylvania Museum and School of Industrial Art—an institution founded as a memorial of the International Exhibition, and destined to be a permanent resort for the Public, as well as a school of instruction.

Being thus provided with ample and handsome accommodations for the proper exhibition of mineral and metallurgical collections, and having already secured so large a number, we desire on behalf of the Institute, to make known the opportunity thus offered for the disposal of exhibits of this class in a way which will perpetuate their usefulness, both as displays for the general visitor and as objects of study for the professional inquirer.

The collections given to the Institute will be exhibited with due regard to their preservation in good condition. The donor's name will be attached to each specimen, or set of specimens, and otherwise published as occasion serves—perhaps in a special catalogue to be hereafter prepared.

The advantages of this disposition are evident. The articles will not be subject to the risk and cost of removal to distant points, but will be removed by the Institute, at the close of the Centennial Exhibition, to the Memorial Hall, and suitably arranged there for future display. They will receive for years to come the special attention of the members of the Institute, which is the only national society of mining and metallurgical engineers in the United States, and includes the leading practitioners in these and cognate professions in all parts of the country. At the same time they will be accessible to the general public in a locality not only most appropriate and convenient, but also inseparably associated with the great occasion which brought so many treasures of industry together from all the nations of the world. It seems to us, apart from the interest of the Institute in the matter, that the deposit of these collections in the city of Philadelphia is a deserved recognition of the public spirit and generous enthusiasm shown by the citizens of that place in the support of this great undertaking under many difficulties and discouragements.

We shall be glad to communicate with you further concerning such part of your exhibit, or such drawings, photographs, maps, models, reports, statistics, etc., bearing upon mineralogy, geology, inorganic chemistry, metallurgy, or mining, as you are willing to give to the Institute; and we trust that you will inform yourself fully before deciding to make other dispositions.

ECKLEY B. COXE,
THOS. EGGLESTON,
JOHN S. ALEXANDER,
R. W. RAYMOND,
WM. G. NEILSON,
Committee.

Judges Awards.

CORRECT LISTS OF JUDGES AND OF THE SUPPLEMENTARY AWARDS TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

GROUP 1.—American—Holley, A. L., 56 Broadway, N.J.
Hunt, L. L. D,, F. R. S., Prof. T. Sterry, St. James Hotel, Boston, Mass.
Safford, Prof. J. M., Nashville, Tenn.
Axtell, S. B., Santa Fe, N. M.
Fritz, M. E., John, Bethlehem, Pa.
Savage, Austin, Boise City, Idaho.
Keyes, M. E., W. S., Eureka, Nevada.
Prime, Jr., Prof. F., Easton, Pa.
Addy, Matthew, Cincinnati, Ohio.
Broadhead, Prof. G. C., Pleasant Hill, Mo.
GROUP 1.—Foreign.—Bell, M. P., F. R. S., Isaac Lowthian, Great Britian.
Althaus, Ernst F., Breslau, Germany.
Simonin, Louis, Paris, France.
Valton, F., France.
Akerman, R., Stockholm, Sweden.
Jottrand, Achille, Belgium.
Nicholsky, N., Russia.
Jossa, Nicholas, Russia.
Kjerulf, Dr. Th., Christiana, Norway.
Cortazar, Don Daniel de, Spain.
GROUP 2.—Gillmore, U. S. A., Gen, Q. A., care D. van Nostrand, New York.
Beckwith, Arthur, 134 Fifth Ave., N. Y.
Cox, Prof. E. T., Indianapolis, Ind.
Tyndale, Gen. Hector, Philadelphia, Pa.
Wurtz, Henry, Hoboken, N. J.
GROUP 2.—Foreign.—Smith, M. A., R. H. Soden, Great Britain.
Seelhorst, Dr. G., Nuremberg, Germany.
Bussy, M. Ch. des, Paris, France.
Nordenskiold, Adolf F., Sweden.
Notomi, K., Japan.
GROUP 14.—American.—Cox, L. L. D., M. D., C. C., Washington, D. C.
Ames, Jr., M. D., Azel, Wakefield, Mass.
(No foreign judges.)
GROUP 18.—American.—Ricker, Robert E., Elizabeth, N. J.
Morris, Gen. T. A., Indianapolis, Ind.
Slataper, Felician, Pittsburgh, Pa.
GROUP 18.—Foreign.—Galton, R. E., C. B., F. R. S., Capt. Douglas, Great Britain.
Pontzen, Mr. Ernst, Austria.
Schaar, Mr. E. F. A., Belgium.
GROUP 19.—American.—Newton, C. E., Isaac, N. Y.
Griffith, J. W., Portsmouth, N. H.
Goodspeed, H. C., Salt Lake City, Utah.
GROUP 19.—Foreign.—Rich, R. E., Col. F. E., Great Britain.
GROUP 20.—American.—Porter, C. T., Newark, N. J.
Belknap, Joseph, New York.
Moore, James, Philadelphia.
Allen, Horatio, "Homewood" South Orange, N. J.
Emery, Chas. E., 7 Warren st., N. Y.
GROUP 20.—Foreign—Barlow, C. E., W. H., Great Britain.
Reuleaux, Prof., Germany.
Petroff, Nicholas, Russia.
Brugsch, Emil, Egypt.
GROUP 21.—American—Scott, Irving M., Union Iron Works, San Francisco, Cal.
Blelock, Geo. H., Springfield, Mass.
Durfee, W. F., Wis. (56 Broadway, N. Y.)
Anderson, Prof. John A., Pres. Kan. State Agric. College, Manhattan, Kansas.
GROUP 21.—Foreign—Anderson, L. L. D., C. E., John, Great Britain.
Perier, M. Le Commandant F., France.
Augstrom, C. A., Sweden.
Gobert, (Fils) August, Belgium.
Reifer, Felin, Austria.
GROUP 23.—Agricultural Machines, Implements, etc.—American—Reynolds, Hon. John P., Chicago, Ill.
Grinnell, Jas. S., Washington, D. C.
Waring, Jr., Geo. E., Newport, R. I.
Bruce, James, Corvallas, Oregon.
GROUP 23.—Foreign—Coleman, John, Great Britain.
Saldanha, Don Jose de, Brazil.
Rosillo, Don Fermin, Spain.
GROUP 25.—American—Henry, L. L. D., Prof. Joseph, Sec. Smithsonian Institution, Washington, D. C.
Barnard, S. T. D., L. L. D., Prof. F. A. P., Columbia College, N. Y.
Hilgard, Prof. J. E., U. S. Coast Survey, Washington, D. C.
Watson, Prof. J. C., Ann Arbor, Mich.
Oliver, Gen. Henry K., Salem, Mass.
Bristow, Geo. F., New York City.
GROUP 25.—Foreign—Thompson, L. L. D., D. C. L. F. R. S., Sir Wm., Great Britain.
Shiedmayer, Julius, Germany.
Lavasseur, E., France.
Kupka, P. F., Austria.
Perret, Edw. Favre, Switzerland.
GROUP 26.—American—Eads, Jas. B., C. E. South Pass Jetty Works, 122 Common st., New Orleans, La.
Franklin, Gen. Wm. B. Hartford, Ct.
Hunt, R. M., 49 W. 35 st., New York City.
(Warring, Col. Geo. E., Jr. of Newport, R. I., also acted with this group.)
GROUP 26.—Foreign—Hawkshaw, Sir John, C. E., F. R. S., Great Britain
Lavoinne, M., C. E., France.
De Silver, J. M., Continho, Brazil.
Fynje, J. G. W., Netherlands.
Maheiro, Lowrenzo, M. E., Portugal.
GROUP 28.—American—White, Hon. Andrew D., L. L. D. President of Cornell University, Ithaca, N. Y.
Gilman, D. C., L. L. D., Pres. St. John's, Hopkins University, Baltimore, Md,
Gregory, Hon. J. M., L. L. D., Pres. Ill. Ind. University, Champaign, Ill.
Hoyt, Hon. J. W., M. D., L. L. D., Madison, Wis.
GROUP 28.—Foreign—Reed, Sir Charles, Great Britain.
Fouret, M. Rene, France.
Marin, Col. John, Spain.
Torell, Prof. Dr. Otto Martin, Sweden.

SUPPLEMENTARY AWARDS.

GROUP 16.—Military and Sporting Arms, etc.,—Engineer Bureau, U. S. War Department.
Ordinance Bureau, U. S. War Department.
GROUP 20.—*Dudgeon, Richard, New York, Rotary Engine.
GROUP 25.—Thurston, Prof. R. H., Hoboken, N. J., Machine for Testing Strength of Metals.
GROUP 26.—Detroit Bridge & Iron Works, Detroit, Mich., Bridge over Missouri River at St. Josephs, Mo.
Gunpowder Pile Driving Co., Philadelphia, Gunpowder Pile Driving Machine.
Keystone Bridge Co., Philadelphia, Improvements in Pivot and Swing Bridges, Steel Arched Bridge and Riveted Columns.
Smith, Gen. Wm. Sooy, Maywood, Ill., Drawings of Pneumatic Caisson.
Lowthrop, F. C., Trenton, N. J., Plans of Iron Bridges and Turntables.

As much dissatisfaction was expressed by some disappointed exhibitors, with respect to awards made by various groups of judges, a special committee was lately appointed consisting of Messrs, Kimball, Morrell, Corliss, McNeil and Dufur, to examine all contests, appeals, and communications from dissatisfied exhibitors. This committee organized to act under the following rules, which it will be noticed are loosely drawn, (perhaps intentionally) especially No. 2:

"Rule No. 1. No exhibitor desiring an award shall "be deprived of the same by reason of the irregularities, "neglect or oversight of any judge or judges, or for any "other cause, provided said failure has not been occa-"sioned by the negligence or impropriety of the exhib-"itor himself."

"Rule No. 2. Reports and awards shall be based up-"on inherent and comparative merits. The elements "of merit shall be held to include considerations relat-"ing to originality, invention, discovery, utility, quality, "skill, workmanship, fitness for the purposes intended, adoption to public wants, economy and cost."

"All persons whose exhibits have been fairly exam-"ined by the former judges, will see by Rule No. 1 that "they are not entitled to a re-examination. All appeals "must be presented to the committee at Room No. 9, "Judge's Hall, on or before the 4th of October."

The Commission then selected 12 gentlemen as a group of Judges on Appeals, who met and organized on the 10th inst., with Jas. L. Claghorn, of Philadelphia, as Chairman, and Henry K. Oliver, of Salem, Mass., as Secretary, and the following assignments were made:

GROUP 1.—John Fritz, M. E., Bethlehem, Pa.; Chas. Staples, Jr., Portland, Me.; Coleman Sellers, Philadelphia.
GROUP 2.—Gen. Hector Tyndale, Philadelphia; Messrs. Sellers and Claghorn.
GROUP 14.—Messrs. Fritz, Staples, Sellers, and Prof. Henry H. Smith of Penn. University, Philadelphia.
GROUP 16.—Messrs. Staples and Sellers.
" 18 " Staples, Sellers and Fritz.
" 19 " Staples, Sellers, Fritz, and Edward Conly, Cincinnati, Ohio.
GROUP 20.—Messrs. Staples, Sellers, Fritz and Conly.
" 21. " " " " "
" 25. " Smith, Oliver, and Prof. S. F. Baird, Washington, D. C.
GROUP 26.—Messrs. Staples, Conly, Sellers and Fritz.
" 28 " Oliver, Smith and Baird.

By reference to the NEWS of the 14th inst. the classes of exhibits to which these groups refer can be ascertained. CHAS. J. MOORE, C. E.

Philadelphia, Oct. 18th, 1876.

SPECIFICATIONS

FOR

Steel Cable Wire, for the East River Suspension Bridge.

1876.

1. Sealed proposals will be received by the Trustees of the New York and Brooklyn Bridge, up to the 1st day of December, 1876, for the manufacture and delivery in Brooklyn, N. Y., of 3,400 net tons or 6,800,000 lbs. of Steel Cable Wire, for the East River Suspension Bridge.

2. For the information of parties living abroad it may be stated, that the East River Bridge will connect the two cities of New York and Brooklyn, which are separated from each other by an arm of the sea, called the East River. That the Bridge has one main span of 1,600 ft., and two side spans of 930 ft. each, besides approaches at each end, making a total length of more than one mile. The main floor is suspended by 4 cables, each 15 in. in diameter, each cable composed of 6,300 parallel laid wires, which are laid up in place, and it is for the manufacture of these cables that the steel wire, called for in these specifications, is required.

3. The general character of the wire is as follows: it must be made of steel; it must be hardened and tempered; and lastly, it must all be galvanized.

4. The size of the wire shall be No. 8 full, Birmingham Gauge. A length of 14 ft. must weigh exactly 1 lb. before it is galvanized, but the weight of the galvanized wire is taken in making up the 3,400 tons.

5. Each wire must have a breaking strength of no less than 3,400 lbs. This corresponds in wire weighing 14 ft. to the lb, to a rate of 160,000 lbs. per sq. in. of solid section. The elastic limit must be no less than 47-100 of the breaking strength, or 1,600 lbs. Within this limit of elasticity, it must stretch at a uniform rate corresponding to a modulus of elasticity of not less than 27,000,000 nor exceeding 29,000,000. The quality of the wire, in regard to its stretching, is further alluded to under the head of "Tests."

QUALITY OF WIRE.*

6. The rods of which the wire is made, must be of a superior quality of steel, suitable for wire purposes. It is not implied that the highest priced steel shall be used, such as is required for fine cutlery, springs, or the like, but it is only a superior steel rod, which will make a wire that comes up to the standard here laid down.

In case the billets or rods are not made by the contractor for the wire, it is to be understood that the inspector, on the part of the Trustees, is to have ample facility to satisfy himself, by ocular proof, that they are actually made out of suitable steel, and from uniform stock.

HARDENING AND TEMPERING.

7. The standard called for in these specifications, demands that this steel wire shall be of a uniform medium quality; that is, it must be neither too hard or high in its character, nor too soft or low in its temper. In order to insure this uniform quality, it is necessary that all the cable wire shall undergo the operation of hardening and tempering. The particular manner in which this operation shall be performed is not prescribed here, but is left free to the manufacturer. There are at least four methods known to the Engineer, all of which can produce good results, if properly adapted to this size of wire. Some of these processes are controlled by patents; others are of a secret nature. Whatever the process pursued by the manufacturer may be, the Engineer, or his inspector, must have satisfactory evidence that every ring of wire has undergone this operation. At the same time, the manufacturer must not loose sight of the fact that the wire is to be galvanized, after being hardened and tempered. It is not intended, however, that this paragraph shall be an absolute bar to any other mode or process of manufacture of the steel and steel wire, provided the requirements in the foregoing paragraphs are strictly fulfilled; it being believed, at the same time, that only the operation of hardening and tempering will produce such wire.

GALVANIZING.

8. The cables of the East River Bridge are suspended directly over a salt water stream, and are in addition exposed to the salt air of the neighboring sea-shore Experience has shown that the ordinary means of protection, such as paint, oil or varnish, which would be ample in the interior, are totally inadequate to prevent rusting, in localities so near the coast. The only certain safe-guard is a coating of zinc, which acts by its absolute air-tightness, as well as by its galvanic action, and is not easily abraded.

The galvanizing must be done throughout, in a thorough and perfect manner; each ring will be inspected in this regard by the inspector, when he tests the wire. All rings will be rejected which show spots imperfectly covered, or are full of rough lmups, showing a defective stripping. The galvanizing must be of uniform thickness, and must not scale off, or show any cracks, when the wire is bent.

The attention of the manufacturer is particularly called to the point that he must galvanize at such a temperature and in such a manner as not to destroy the temper of the wire. The manufacturer must run the whole risk in this respect, because the wire is inspected and tested after it has been galvanized. Samples which have been received and tested, show that it is not difficult to reconcile these two operations, and that when proper caution is exercised, and the parties possess sufficient experience, the wire can be properly galvanized without impairing the temper.

STRAIGHT WIRE.

9. All the wire called for in these specifications must be "straight" wire; that is to say, when a ring is unrolled upon the floor the wire behind must lie perfectly straight and neutral, without any tendency to spring back in the coiled form, as is usually the case. This straight condition must not be produced by the use of straightening machines of any kind, as they only injure the strength and elasticity of the wire. As the cables can only be laid up with straight wires, this necessity is obvious.

To produce straight wire it is necessary to lead the wire from a point within the galvanizing trough in a straight line, under considerable tension to the guide sheave or winding drum, and to locate the sheave or drum at such a distance as to permit the wire to be cooled and set before it is coiled thereon. And also to make the sheave or drum of such size as will not cause a permanent bending of the cooled wire. Any method of cooling the wire more rapidly will permit of a less distance between the trough and drum. As the process above described has been patented, the Trustees of the bridge have arranged with the patentee in reference to all the wire called for in these specifications, so that parties furnishing said wire will not be required to pay a royalty thereon.

MODE OF TESTING.

10. Owing to the uncertain character of steel, and the percentage of rejection that usually attends the finished product, notwithstanding all the care and the amount of selection it may have undergone in the various stages of its manulacture, the Engineer considers it absolutely necessary that every ring should undergo a test when finished.

There will be four kinds of tests.

Firstly.—One ring in every forty (40) will be tested, as follows: a piece of wire, sixty (60) feet long, will be cut off from either end of the ring, and it will then be placed in a vertical testing machine. An initial strain of 400 lbs. is now applied, which should take out every crook and bend. A vernier gauge, capable of being read to 1-10,000 of one foot, is so attached as to indicate the stretch of 50 feet of the wire Successive increments of 400 lbs. strain are then applied, and the vernier read each time, until a strain of 1600 lbs. is reached.

The conditions now are as follows: that the amount of stretch for each of these increments shall be the same, and that the total stretch between the initial and terminal strains shall not be less than 97-1000 of one foot, equal to 194-100,000 of the 50 feet. And furthermore, on reducing the strain to 1,200 lbs. there shall be a permanent elongation not exceeding 1-100,000 of its length.

The same wire will then be subjected to a breaking strain, and the total amount of stretch noted. The minimum strength required is 3,400 lbs., equal to an ultimate strength of 160,000 lbs. per square inch. The minimum stretch, when broken, shall have been 2 per cent, in 50 feet, and the diameter of the wire at the point of fracture shall not exceed 15-100 of one inch.

Secondly.—One ring out of every five shall be tested by having a piece 6 feet long cut off, and placed in a testing machine with vernier gauge, so attached and graduated as to read the stretch of 5 feet of length to 1-10,000 of one foot. When strains shall be applied in the foregoing order, and the vernier read at each point respectively, if the results correspond with the requirements for the 50 feet lengths

*NOTE.—It may not be amiss here to present a few of the reasons which led to the selection of the size and quality of steel wire adopted in these specifications. In all previous bridge cables, charcoal iron wire of either No. 10 or No. 9 gauge was used. In Iron wire it is well known that a remarkable increase in strength is developed by the process of cold drawing. Thus a bar 1 inch square having a strength of 40,000 or 50,000 lbs. to the square inch, will show a rate of from 90,000 to 100,000 lbs. per square inch of section, when drawn down to No. 9 or No. 10 size. In steel this is also true to a moderate extent, while the process of tempering and hardening still farther increases the strength. The use of this size has three advantages. The first is that fewer wires are required to make up the cable, thus reducing labor. The second is, that its greater weight offers greater resistance to the wind—a most important consideration when laying a cable in a locality as exposed as the present one. The third, that it offers less comparative surface to rust. The use of a size much coarser than No. 8 is, however, barred by the extreme stiffness of the material, making it very troublesome to handle.

In the question of strength, as regards the choice between using iron and the various grades of steel for cables, we find that the great length of the main span at once excludes the use of iron or the lower grades of steel. Even with the quality called for in these specifications, one-third of the strength is taken up in supporting its own weight; hence the use of iron wire bearing only 90,000 lbs. per square inch, or of the lower grades of steel is not admissable, because it would necessitate a cable of such weight and size that it would become unmanageable, and involve the greatest difficulties in making it. I, at least, would not be willing to undertake it. The rate of strength decided upon, namely, 160,000 lbs. to the square inch, represents a fair mean of all the objects that it is desirable to attain. It is true that steel wire of a very much higher rate of strength can be made. Its use would produce a cable much smaller than 15 inches in diameter. Now it is just as undesirable to have too small a cable as too large a one. A certain bulk of cable is absolutely necessary in order to give a mass, anp the inertia to resist dangerous oscillations in the cable itself. I would furthermore state, that the dimensions of the anchor chains, the size of ihe saddles and plates, the weight of the anchorages and the shapes of the towers, have all been proportioned for a cable 15 inches in diameter, and made of steel wire of the strength above given. W. A. R.

as regards modulus and limit of elasticity and ultimate strength, and the stretch of 5 feet of length exceeds 3½ per cent. of its length, the ring will be accepted; otherwise it will be rejected.

Thirdly.—Every ring will be tested by having a piece 16 inches long cut from either end, and placed in a testing machine, having a vernier gauge so arranged as to include one foot in length of the wire, and shall be graduated as finely as practicable. Each piece will be subjected to the same strains mentioned for the 5 feet lengths, and the results must correspond with the requirements, excepting that of the ultimate stretch.

These shorter pieces are used to expedite the testing and to economize wire; but the requirements mentioned in connection with the 50 feet tests will be insisted on, and any doubt as to the results with the shorter pieces may be solved by testing a piece 50 feet long. And in case one ring in forty (40) should not be a sufficient test of the quality, then the inspector can select, at closer intervals, rings for 50 feet tests. If want of uniformity is suspected, a piece 5 feet in length may be taken from the other end of the ring.

Fourthly.—Every ring will be subject to a bending test by cutting off from each ring a piece of wire one foot long, and coiling it closely and continuously around a rod one-half inch in diameter, when, if it breaks, it will be rejected.

GENERAL REMARKS ON TESTING.

At the first glance these tests may seem rather onerous and exacting in their requirements, but they will not appear so to a manufacturer who has been in the habit of having his work tested, and is desirous of not only maintaining, but adding to an established reputation. The spirit of these tests does not consist so much in the rejection of a random ring here and there, as it does in impressing on the operatives, and all concerned, the assurance that no bad work can possibly pass the inspection. It is only when this has become a certainty that we can rely upon a steady and uniform character in the quality of the wire.

Nothing is more common, for instance, than to lose the whole of the day's work by reason of a wrong temperature in the galvanizing bath, or to spoil tons upon tons, by faulty tempering, all of which would be pushed for acceptance if there were no daily inspection going on. This is usually the case toward the end of a contract when the final deliveries are wanted in a hurry. Finally, it may be said that in these tests no unattainable standard has been set up, but the requirements are such as can be filled with ease and certainty by any manufacturer.

INSPECTORS AND MACHINES,

12. The inspection will be performed by the authorized assistants of the Engineer, or by specially appointed inspectors. They are paid by the Trustees. The testing machines, however, as well as all manual labor required in handling the wire, preparing the specimens, and the actual work of testing, must be furnished by the manufacturer. The testing machines will probably not be more than three in number, and this will be comparatively a small expense, as their capacity need not exceed two gross tons. After the system of inspection has once been thoroughly organized it will be found that the expense connected with it forms an exceedingly small percentage of the total cost of the wire. Proper room and facilities must be furnished for this work.

In case of any dispute arising between the inspector and the manufacturer, the Engineer is to be the sole arbiter.

SIZE OF RINGS.

13. Long rings are indispensable. The weight must average 60 lbs. None weighing less than 50 lbs. will be received, and they may be as much heavier as can be made, provided the ends are of uniform diameter. With the recent improvements in rolling machinery, long rings have become the rule instead of the exception, as was formerly the case. By having long rings the time and labor of splicing the wire is reduced proportionably. The splicing being the weakest spot, we increase the average strength by having long rings, and by reducing their number. The wire is, besides, of so coarse a size, that even a 60 lb. ring will not much more than reach half-way across the main span. Hence, at the best, the relative number of splices will be far greater than in any previous cable. The rings must be of such a diameter as not to give the wire a permanent bend. The inspectors will also pay particular attention that both ends of these long rings have the same uniform gauge and thickness—as wire of uneven weight cannot be properly regulated in making the strands. This examination will be made before the wire is galvahized.

Only one nipper mark can be permitted on the end of a ring, and that at a distance not exceeding 5 inches from the end.

When the end of the wire is pulled through the draw plate for the purpose of fastening it to the block, it must be done at one operation, and not by successive applications of the nippers, as is usually done.

The dents caused by the nipper jaws injure steel wire very materially, and hence *not more than one is allowed.*

GENERAL REMARKS AND TIME OF DELIVERY.

14. It is required that the manufacturer will at once, upon the giving out of this contract, prepare to make and deliver about 50 tons of this wire. This is necessary, in order that the contractor may make the necessary preparations in the various processes of the manufacture, so as to be able to turn out the regular quantities in the time specified. In these preliminary 50 tons ample time is given to overcome all defects which may exist in the beginning, and also to come to a perfect understanding with the inspectors as regards any doubtful questions which may arise in regard to the modes of testing or the standards required.

The regular deliveries of wire will commence February 1st, 1877. The amount of these monthly deliveries must be no less than 150 tons, and in case it should be found that the cable-making proceeds faster than at present anticipated, the manufacturer must increase this amount to 200 tons, upon being duly notified by the engineer, at least two months in advance.

15. Inasmuch as the precise quaniity of wire in these cables cannot be ascertained until some of the strands are actually made, and all the wire composing a strand has been weighed, the Engineer reserves the right to increase or diminish the quantity of wire called for in this contract by the amount of 200 tons, the same to be furnished at the regular contract price, provided he gives notice to that effect three months before the completion of the contract.

16. All parties who expect to bid on this wire are requested to send samples in accordance with these specifications, the samples to weigh no less than 100 lbs., and to contain two rings. Foreign parties may consign them to E. L. Alexander, 117 Liberty street, New York, marked Bridge wire.

17. The wire intended for shipment should be properly packed, and so wrapped as to avoid injury to the galvanizing.

MANNER OF BID.

18. Bids will be received at so much per lb., GOLD, for the whole amount delivered at the Brooklyn Tower. It is deemed best to place the bids on a gold basis, in order to eliminate the question of the probable changes in the value of the currency for the period of time over which this contract will extend. It would be impossible to foresee these changes accurately, and the margin that the contractor would be forced to allow himself, would, of necessity, be against the interests of the Bridge. The duties on both the steel rod and on the finished wire are payable in gold. The duties on this kind of wire are at present 2½ cents per lb., and 20 per cent. ad valorem, The cost of lighterage from the foreign steamship wharves on the North River, to the wharf at the Brooklyn Tower, is about 65 cents per ton in currency. Ocean freights of course differ, according to shipping port.

No bid will be received which does not include the duties.

BONDS.

19. In order to insure the complete and satiafactory performance of the requirements laid down in these specifications, the successful bidder shall give good and sufficient bonds to the amount of $50,000—gold. This will take the place of the back percentage which has usually been retained in other contracts.

PAYMENT.

20. The Trustees will pay on the 10th of every month, in full, in gold, for all the wire delivered during the previous month.

21. It is furthermore to be understood by the successful bidder, that if at any time during the performance of his contract he shall fail to comply with the terms of these specifications and produce a wire which does not come up to the tests required, and has to be constantly rejected by the inspectors, or if he is manifestly unable to produce the necessary quantity in the required time, the Engineer of the Trustees shall duly and officially notify him, in writing, of this neglect and failure on his part, and if, notwithstanding this notice, the required improvement is not made, then the Trustees may declare his contract null and void, and shall have the right to contract with other parties at either the same price or some other price, and if loss should occur to the Trustees by this transaction, that they then have the right to take the whole or part of the aforementioned bonds of $50,000, to cover themselves from such loss.

22. On the other hand, if from some unforeseen circumstance, which at present the Trustees have no knowledge of, they should be compelled to suspend operations on the work, they reserve the right to notify the contractor to suspend the delivery of the wire, either for a fixed or an indefinite period, provided they serve him with a notice to that effect, at least three months before such suspension; and the fact of having given such a notice is to be a bar against any claim for damages arising from the suspension of this contract.

23. The Trustees reserve the right to reject any or all the bids that may be offered, or to divide the contract into not more than four portions, in case it should prove to their interests to do so.

24. Bids must be addressed to the TRUSTEES OF THE NEW YORK AND BROOKLYN BRIDGE, No. 21 Water street, Brooklyn, N. Y., and endorsed "Proposals for Cable Wire."

W. A. ROEBLING,
Engineer New York and Brooklyn Bridge.

INSTRUCTIONS TO BIDDERS.

1. All proposals must be made upon the form accompanying these specifications, all the blanks of which must be filled.

2. The full name and address of the parties bidding shall be given, and a seal attached to all signatures.

3. The guaranty attached to the bid must be signed by two responsible guarantors, known to be good and sufficient by these Trustees, or certified to be such by some responsible person so known.

4. Parties making bids are understood as accepting all the terms and conditions contained in the specifications, the specifications being considered a part of the agreement.

5. The bidder must be a manufacturer of steel wire, and must give satisfactory evidence of his ability to furnish the quality and quantity of wire required, within the specified time.

Water Works, Ancient and Modern.*

BY E. H. D'AVIGDOR.

(*Continued from page* 344.)

The foundation (flat invert) of the conduit was generally executed of rubble, as were also the abutments; in some few places, where stone was not available, the whole was built of brick; the arches constructed either of roughly shaped stone or of bricks moulded to radius, and the highest level of the water is always kept at least 6 ft. from the atmosphere to avoid any variations of temperature; a precaution which is very necessary when it is remembered that the average extremes of temperature in the environs of Vienna, particularly in the Stonefield, attain more than 90 deg. Fahr. *in the shade*, 92 deg. being no unusual summer heat, while but few winters elapse without the mercury having fallen to 0 deg. or thereabouts; the variations in the sun being of course still greater. On the aqueducts, which are of course exposed to the full force of sun and wind, the abutments of the canal are 4 ft. thick, while their usual thickness is but 1 ft. 10 in. (all Austrian measure). The engineers, therefore, kept the Roman principle of isolation from the external temperature and complete inaccessibility to external impurities constantly before them.

The main conduit of the Vienna Water Works has been repeatedly criticised on the ground of the extremely heavy dimensions of the masonry, and the reproach of waste of material has frequently been expressed. This criticism appears to be unfounded. The total length of the canal being nearly 68 English miles it was of course impossible to find the best material everywhere available for a continuous mass of masonry. In this respect a water conduit is a very different thing from a railway. In the construction of the latter great care must generally be devoted to certain works which have to be executed in certain detached positions, and for which the materials can, if required, be brought from some distance on the bank itself by means of a temporary road. This is not the case with water works generally, and was certainly far from being possible in the Vienna works. For the large aqueducts the material was carefully chosen and brought from long distances, but for the great mass of masonry in the current conduit it would have been impossible to use stone carted from a distance without an enormously increased outlay, the more so as, except from Kaiserbrunn to Reichenau and from Stixenstein to Ternitz, there is no convenient high road parallel to the canal, but all the roads intersect the line at an acute angle. It became necessary, therefore, to use the stone nearest to and most convenient for the works, and although all the material employed is of great tenacity and durability, much of it is rather rough, and more is tough and hard to work. To provide for large joints, uneven courses, and, in fact, rough work when no other was possible, very heavy dimensions were adopted; with lighter ones, either other materials would have had to be used at a considerably increased cost, or the supply of water to the town would have been liable to considerable interruption for substantial repairs. In the former case little or no saving could have been effected; the latter could not be contemplated for a moment. For it must not be forgotten that while Paris derives its best drinking water from the *two* aqueducts Vanne and Dhuis, the city still possesses its old sources of supply, so that even if both the new works were under repair at the same time (which is extremely improbable) the town would not suffer from positive drought. Vienna, on the other hand, is now absolutely dependent on the springs of the new works, the Danube filter beds only supplying the ridiculously small quantity of about 1½ million gallons daily, and nearly all the town wells and pumps drawing water from them having been closed by order of the sanitary authorities. With the prospect of such serious consequences of an interruption before them, the promoters of the new water works therefore determined to be on the safe side, and to avoid all substantial repairs whatever; they adopted dimensions which appear extraordinarily large, but they have attained their object, since the repairs which have had to be executed since the completion of the aqueduct in 1873 are hardly worth mentioning. Only a few small cracks in the coat of cement lining the interior of the conduit have taken place; they were so fine that the greatest care had to be used to discover them at all, and the leakage through them is incommensurable, since the minute quantity escaping only appeared like a slight dew on the face of the aqueduct. In no case has any settlement whatever taken place in the masonry, nor have any of the arches cracked, although, as will be mentioned further on, some of them are of great span and others of considerable boldness.

Hydraulic engineers labor under the disadvantage that most of their works are hidden away out of sight after completion. While the railway engineer has the satisfaction of knowing that thousands of people are daily carried across the great viaducts he has executed or pass through the tunnels he has driven, that all his works are open to the inspection of his colleagues at any future time, and that the results of his labors are therefore always vividly brought back to the memory of the public, we water engineers are obliged to bury away our mains and conduits in the ground, and the most tedious and difficult part of the works we have carried out is lost to sight and therefore often to memory also. Even those most interested in these works can do no more than open the cover of a manhole and occasionally look down into the cool darkness, where they will see nothing but a bit of polished dripping wall, and hear nothing but the echoes of the murmuring water. The anticipation of this inevitable result induces me to dwell most particularly on the portions of the Vienna aqueduct which can no longer be examined and appreciated; I mean, of course, the tunnels and deep foundations. I have already mentioned that there are 21 tunnels on the line of the Vienna works; their total length is 8,400 yards English, or nearly five miles. The longest and most difficult is that of Kaiserbrunn, which has also been referred to above; from the spring to the termination of the tunnel at Hirschwaug is just under two miles, and it was divided into twelve sections by adits or drifts driven into the rock at right angles to the line from the deep gorge of the Schwarzau already alluded to. These adits vary in length from 70 to 200 yards. The rock is hard dolomitic limestone intersected by numerous large fissures and small cracks; most of the former were filled with sand and detritus through which quantities of water found their way into the works and retarded their progress considerably. Some of the cracks were so continuous as to isolate large blocks of stone, which, losing their support by the shock of the explosions used, fell into the tunnel and had to be broken up and removed; in such places and in others where similar results were anticipated, the tunnel was lined with very substantial ashlar masonry. The side tunnels or adits were driven with a rising gradient from the surface, to facilitate the removal of the material, which was run out on dogs or little trucks on a temporary railway of 22 in. gauge, and tipped into the river wherever the obstruction was not likely to disturb the channel. But in many places the extreme narrowness of the stream and the steep, almost vertical, slope of the banks prevented this course being adopted; in such cases temporary bridges had to be erected and the railway prolonged along the opposite bank to a convenient point where the stuff could be run to spoil. Before the headings met great difficulties were caused by the want of ventilation in the different sections; and the loss of time caused by the vapors hanging in the drifts long after the blasting was over retarded progress greatly. Turbine ventilators were erected at the upper end of the tunnel near the spring and at several of the adits; the former was driven by a belt from one of the portable engines used for pumping, the latter by hand.

(*To be continued.*)

* A course of papers delivered at the Austrian Institution of Engineers and Architects, December, 1875, and January, 1876.

What a "Flats" House Should Be.

The papers and discussion under the auspices of the committee on "House and Home" took up the subject of "Flats," or apartment houses, as compared with isolated houses, and some very good idea were obtained as to the comparative advantages, and the requirements of successful apartment houses.

The following summary has, I think, value for a larger audience than the one to whom it was addressed:

A flat house ought, in the first place, to be free from the odor or idea of a tenement house. If it is small, meanly built, or in a common location, the tenement house is immediately suggested to the mind, and it is consequently a failure.

Whilst undoubted respectability is an absolute necessity, the very expensive and over-commodious flat building is to be avoided. As an investment it will not pay. The Stevens' House is an example of this kind. Those who can afford to pay from three thousand dollars to six thousand dollars yearly for a city residence will, as a rule, have a house to themselves. The flat in this country is, and will be, sought after by persons of moderate means and those who have retired on a respectable competency.

They ought to be built so that they can be rented for from about eight hundred dollars to two thousand dollars, and should have from six to nine rooms besides closets, water-closets and bath-rooms.

The principal entrance and staircase should be handsome, and each family should have an entrance from the latter similar to a street door, with bell, number, etc. This ought to open into a private hall, which will communicate with every room, if possible, without passing through another room.

The kitchens and servant's room should be in the rear, and so that the visitor will not have to pass them in getting to the parlor. The kitchens should connect with the cellar or basement by fire-proof back stairs, and dumb-waiters with speaking-tubes and bells.

These waiters should be accessible from the street through the basement, so that grocers, butchers and others can bring in goods and send them up, advising the servant at the same time on the tube and bell.

There should be a trunk room and coat room for each tenant in the basement.

The janitor, who ought to have a residence in the basement, and a small office with bell and tube from the same to each tenant—ought to be a man of genteel appearance and of good address. His duties ought to be: to see to the main and basement entrances; to keep clean halls, stairs, areas, sidewalks and basement; to light the halls and basement (these lighted from proprietor's metre); to take away ashes (which ought to run from the kitchens by a chute to fire-proof receptacle in the basement), and to see to heating and pumping, if the latter is necessary.

The heating and pumping for the building ought to be done by steam, and all the hot water for baths, wash-tubs and basins ought to be heated by steam, leaving cooking only to be done by the family fire.

There ought to be a small drying room, operated by steam heat, for each family, either in the attic or connected with their kitchen.

There ought to be two steam machines, a large one and a small one; the large one to run and do all the work from fall to spring, except in very severe cold weather, when the small one can be brought in to assist; but the principal work of the small one is to work the pump, to heat the water, and to operate the clothes driers in summer.

The janitor will, of course, need assistance, particularly in winter, on account of the furnaces.

The proprietor will have to pay the janitor, the gas bills from his own metre, and the coal bills for the steam furnaces.

Two or three rooms in each flat ought to have mantels and grates, and every room should have direct outdoor air and light if possible.

Flat buildings without elevators should not be more than five stories high, and an elevator will not pay unless the building will contain at least a dozen families.

No flat building should be built on less than two city lots, i. e. 50×100 feet, and the entrance ought to be only two or three steps up from the street with the basement, which will be light and dry, used as before mentioned.

The flat building can, of course, be built to any size, the larger the better, with one, two, or even four elevators.

A building, say 200×509 feet, ought to be built with an interior court, and a grand entrance into the same for carriages and pedestrians. Such a building ought to have several sizes of flats, some without kitchens or drying-rooms, and there ought to be a public laundry and a public restaurant connected with such a building as well as other stores.

This ought to have several elevators and staircases, also private stairs and dumb waiters to basement, and and ought to be built at least seven stories high, and as nearly fire-proof as possible.—*N. Y. "Sorosis" Club.*

OUR NEW ENTERPRISE.

In accordance with our advertisement, we commence this week the publication of Baldwin Latham's celebrated work on "Sanitary Engineering," and will continue it from week to week until it is completed.

It is hardly necessary for us to refer to the importance of an efficient sewerage and drainage of our streets and houses; the mortality lists of every considerable city throughout the civilized world, coupled with the carefully prepared reports of Health Commissioners, attest this in a way that cannot but carry conviction to every student of these statistics.

In entering upon the re-publication of such an extensive work as that of Mr. Latham, we trust that those of our readers whose specialties lie in other directions than this, will not feel discouraged at the prospect. We have selected this subject as being one, that perhaps of all others, would recommend itself to the largest numbers in the engineering and architectural professions, besides enlisting in its behalf many members of the medical profession, and also a goodly share of the general public, who are sufficiently interested in sanitary reform to be willing to learn what they can of the best methods of promoting it. There are also several branches of trade and manufactures that are dependent for support on sanitary improvements; of these we especially claim the patronage on the grounds that we propose to publish for their benefit, the latest and best information relating to their special branches of trade, and to so familiarize the public with their importance as cannot but benefit them very materially.

We have laid out a pretty large programme, the efficient execution of which must depend to a considerable extent upon the assistance which the professions and trades directly interested may lend us; as we progress, therefore, we invite communications and criticisms from any who may feel inclined to favor us; we will be obliged also for reports of city engineers, sanitary commissioners, societies, etc., also drawings and illustrations of sewers and everything entering into their construction and maintenance. By this means we hope to be able to present to our readers such a mass of information on this subject as will render our publication the most valuable one on the subject that has ever been issued.

The volume which we propose to reprint is necessarily written for English readers; in its treatment of the general subject it is equally well adapted to every locality and it is our intention, so far as we can, to either substitute for, or add to, the peculiarly European features of the work such improvements as are essentially American.

The additional expense of our enterprise will be very considerable, and we have no capital to spare in carrying any files of back numbers; we have arranged our scheme with special reference to the convenience of our readers, and we will print only a limited edition over our regular issue of each week; claims for missing numbers by regular subscribers must be made within two weeks of the date of the missing number; papers will not be sent to any but *paid-up yearly* subscribers, and specimen copies will be sent only on receipt of ten cents. We have not been very pertinacious thus far in pressing our claims for the consideration and support of the professions whom we serve; we have preferred to let our journal work its way by force of genuine merit; and we hope we may be pardoned at this time if we urge our *right* to their material support, and solicit from them a liberal response to the enterprise in which we have embarked in their behalf as well as our own.

CITY OF LYNCHBURG.

REPORT OF STANDING COMMITTEES OF THE COUNCIL OF THE CITY OF LYNCHBURG, VA., FROM JULY 1, 1875, TO JULY 1, 1876.

We have perused this little report of fifty pages with profit and pleasure;—with profit; to learn what this little city of 7,000 inhabitants up among the foot-hills of the Alleghanies, has been and is doing for itself. Favorably situated in regard to coal and iron deposits, to be developed at no distant day, with already three railway lines and the James River Canal, and water power, there seems no reason why Lynchburg should not soon develop into a busy manufacturing centre. So far as we can judge it appears to have been dropped in its present location fifty or more years ago, and nothing has occurred since to disturb the sleepy burghers unless it be the completion of an occasional railway line to their doors, by outside parties. If it grows it is because the friction against the outside world carries it along without conciousness or apparent aid from within. Growth in such cases is easier than stagnation. However, we may be egregiously mistaken in regard to Lynchburg.

From the Engineer's Report we learn, (speaking of the water works) that "the original works constructed in 1828 by Albert Stein, C. E., are yet in successful operation. The pump after recent repairs, bids fair to perform its functions for many years to come, and the usefulness of the new and larger pump, constructed in 1868, has been but little impaired" etc. The canal or race supplying the water-power to drive the pumps needs enlarging, and "the reservoir, upon which no improvement has been made since its construction, is not in a desirable condition," being leaky and defective in original construction. About 5.7 miles of cast iron pipe have been laid, from 12" to 3" in diameter. The following interesting paragraphs we quote in full:

The first pipes, laid in 1828, were not protected against corrosion, and the effect of the river water on them has been particularly noticed in some sections of the three inch pipe in Main street. By the formation of tubercles its diameter has been reduced nearly one-half, and hence its utility so impaired that it was found necessary to introduce a new main in the same street, which was done eight years ago. The old one, however, is still in use, but so injured by rust that in some places a tap cannot be made without strengthening the pipe with wrought-iron bands or cast-iron sleeves.

It is safe to assert that some sections of the old mains must be abandoned in ten or fifteen years, which will limit their general durability to the term of sixty years.

The pipes laid in 1868 and protected by a coal-tar coating have not suffered. The quantity of water used has increased from an average daily supply of 225,000 gallons in 1870-1 to nearly 1,000,000 in July 1876. Omitting the quantity used for fire purposes and sewer flushing, there remains 900,000 gallons or about 200 gallons per day among 4,500 consumers. This the Engineer, Aug. Forsberg, regards as extravagant, and enters the usual protest against unwarranted waste, etc., now so familiar to readers of city reports. An interesting table is given taken from the Cincinnati Report which may be new to many of our readers:

Ratio of daily consumption per inhabitant.

	Gallons.		Gallons.
New York,	90	St. Louis,	60
Detroit,	88	Boston,	60
Chicago,	80	Philadelphia	56
Hartford, Conn.,	80	Toledo,	54
Reading, Penn.,	75	Cincinnati,	53
New Haven, Conn.,	75	Baltimore,	50
Albany, N. Y.,	70	Lowell, Mass.,	44
Springfield, Mass.,	66	Cleveland, O.,	43
Buffalo, N. Y.,	63	Providence, R. I.,	30
Brooklyn, N. Y.,	60	Milwaukee,	25
Foreign Cities.			
Dublin,	60	London,	33
Glasgow,	52	Liverpool,	30
Paris,	38	Manchester,	21
Edinburgh,	35	Sheffield,	20

Average of 20 American cities, 61.1 gallons.
" 8 Foreign " 36.1 "

This table exhibits the average daily consumption per capita. In this city we may approximately estimate the same at 150 gallons, which is one and two-thirds time that of New York, seven and a half times that of Sheffield. But recently we have commenced to indulge in the luxurious use of 200 gallons.

The cost of the water is about 5½ cts. per thousand gallons.

In the Street Department we notice the trial of an expertmental stone block pavement which promises good results, the stone being taken from a quarry near the city.

The drainage of the city is by no means in an admirable state, many of the old sewers being simply of plank, without bottoms, leaking in every direction. Speaking of a drain, a sort of elongated cess-pool, which runs diagonally through the city, the engineer recommends its filling in order to save bridging, a sewer to be placed in the bottom for the main city drainage. In speaking of this the engineer uses the following language which to one unfamiliar with "city fathers" may seem quite amusing.

Upon this general plan of a main sewer extending diagonally through the city, a section of the same has been constructed in 13th and Church streets, not as many have supposed it to be, an independent culvert for the support of the road-bed of Church street extension. The peculiar location of this culvert, under a fill of 40 feet, necessitates a structure of the most permanent character, and to that end, a stone-sewer of the egg-shaped form was selected as the most suitable. The first introduction of a structure, so different from our ancient box sewers, has naturally been the cause of much criticism and very frequent expressions of, no doubt, an honest opinion that by somebody's mistake this underground conductor of sewage has been turned up-side down. But the principle of its construction is nothing new in engineering, and it is to be hoped that it will not long remain a novelty here.

In regard to its capacity, I propose, if possible, to allay the apprehensions of those who yet believe that this sewer is too small to answer its purpose.

He then introduces quite a disquisition on the capacity of sewers, fortified with formulæ which no one but engineers can understand and yet which the average member of a board of public works looks wise over and concludes that the engineer is "bizness." So far as said member is concerned the formulæ for centrifugal force would convey as much meaning and serve as wise a purpose.

CORRECTION.

On page 332, top line of 3d column of our issue of Oct. 14th, we managed to leave the fair Columbia "surmounting" a "colossal bull" instead of preserving her usual dignified equilibrium on a "colossal *ball*." That was a "bull" sure enough, and we ask Mr. Moore's pardon for making such a "colossal" one.

We desire to call the attention of our readers to the valuable article which we this week reprint from our cotemporary, *The American Architect and Building News*, and hope that some of the questions that have arisen in the minds of many engineers and architects as to the value of these associations may be satisfactorily answered therein. At another time we will take up the subject of engineering societies and their advantages to the profession at large; at present we can point with some considerable pride to what has already been accomplished by the American Society of Civil Engineers, and from what meagre reports we occasionally receive from other similar societies, we can see that the engineering profession is concentrating its forces, and thereby extending its influences for improvement wherever its members are to be found. This is the season of the year when these societies are most active; let engineers and architects who have never yet realized the importance of giving their active and material aid to the promotion of their profession's influence, now see to it that they give to this question of association their earnest and immediate consideration.

Errata.

In the article "The Centennial Exhibition" of last issue, page 338, 3d column for—"Engineering Thoughts and the Centennial" read, "Gravity—its relation to Engineering—and to all things." In the 19th line from the top, 1st column page 339, for—"specially" read "specifically"; in the 12th line from the bottom 1st column page 340, for—'hundred" read "thousand"—in the blank space of the first paragraph of Memoranda, 3d column page 340, place "43" and for "faster" in the 11th line from the end of the last paragraph of Memoranda, on page 341 read "farther."

The Centennial Exhibition.

BY C. J. MOORE, C. E.

[Written for Engineering News]

[In continuance of our Philadelphia correspondence of last week, which was quite abruptly closed on page 347.]

Regulations on railroad grants, U. S. mining laws, regulations on agricultural and mineral lands, and a pamphlet showing the manner of proceeding to obtain a title to lands. Would it be requiring to much to have asked the Department to explain in addition for the benefit of an enquiring public, the manner of proceeding to obtain a contract to survey public land? A few examples of deputy surveyors' field-books, as actually filled up in the field, would also have been of interest, and descriptions of the instruments they *may* and those they *must* (?) use.

Passing across the other side of the main aisle one finds the large and important collections of minerals, ores and products collected by the exertions and placed in charge of Prof. W. P. Blake, of New Haven, and belonging to the National Museum in the Smithsonian

Institute at Washington. This is undoubtedly the most important collection of ores in this country, and though still very incomplete is a perfect exponent of the ores and minerals of the United States. It is a successful effort to exhibit our mineral resources, especially when one considers the difficulties with which Prof. Blake had to contend "when he went a-begging" for the National collection. First the unappreciative apathy of State legislatures; next, when roused, their insufficient appropriation; next, in some instances their jealous stipulations that their mineral collections should be exhibited under the auspices of their State and not of the nation. These have occasioned considerable vacancies in the collection in the Government building on the part of some States, who exhibit largely and in much variety in their own State Houses or in the mineral annexe of the main building. Those States, however, *did* make considerable appropriations, and placed their collections in the Government building to become, at the close of the exhibition, the property of the National Museum. Among them must be named Nevada, who nobly appropriated $20,000, and has sent the finest collection of silver ores ever brought together, and a larger exhibit than any other State; they not only presented the collection free of cost to the Museum, but also paid, in addition, for the ten cases in which they are to be placed. Gen. Wilder, of Tennessee, must also be mentioned with honor for the energy and perseverence by which he succeeded, when the State had tardily appropriated too small a sum, in collecting and presenting the minerals to the Museum, and also in publishing the excellent account of the agricultural and mineral wealth of Tennessee by J. B. Killegrew, which we shall have occasion to mention again. Prof. Blake was also much aided in the Western States by the energy and enthusiasm of Hon. Thos. C. Donaldson, member of the Commission from Idaho, and a few other individuals have shown much public spirit in the fine collections of ores and minerals they have donated to the Museum.

Prof. Blake intended to represent in this collection the entire progress of the manufacture of the various ores and minerals from the raw material to the finished product, and this selection will be continued in the Museum after the Exhibition closes, but in this he was only partially successful, only a very few of his numerous requests being fully understood and acted upon by those to whom he applied. One thus misses entirely any exposition of the metallurgy of gold, silver, mercury, and zinc, and sees here but partial representations of lead and copper metallurgy, perhaps the best of all exhibits in this line being that of Messrs. Hussey, Wells & Co., of Pittsburgh who show a handsome case containing in duplicate the whole process of making crucible steel from the micaceous specular iron ores to the finished product in bars and ingots broken to show the grain of the metal and different degrees of carbonization; the small billets of iron and charcoal are shown in different stages of the smelting in four crucibles cut in half vertically, so that one sees in the first crucible which has been 1½ hours in the furnace and in each of the others, the exact state of the slightly formed iron and charcoal, second crucible heated 2 hours, third heated 2½ hours, and fourth heated 3 hours, the last showing the complete fusion of the metal which is thus crucible steel. The various specimens of metal are shown bent double cold and hot, broken, and twisted, etc. Park Bros. & Co., show a very handsome trophy in the central aisle also, of homogeneous crucible steel under the same principle of arrangement the raw material being magnetite of Lake Champlain, Missouri and Lake Superior, crushed, washed, and calcined Ore, loop, billet Pig, Puddle Ball, Bloom, Rolled Iron, Blister bar, ingots of steel broken to show grain, hammered and rolled Sheets and Plates, flanged boiler and fire bar plates, bars round, square, and octagon, reaper section, knife blades, oil well forgings, tools of all kinds with *punched* eyes, railroad frogs, files, cutlery, etc. In the centre of the enclosure is an artistically designed pedestal and shaft rising to 16 ft. above the floor made of various shapes of cast steel, at one side of this is the glass case containing the finished products, at the other the iron ore in the first shapes of the metal. The rail around the enclosure is a flat bar 4½"x3-16" twisted cold one turn in 5½"; this is a very striking and instructive display the quality of the steel being regular and excellent.

Another smaller exhibit of a similar character and less complete is that of Collins & Co., Hartford, Conn. who show billets of crucible steel broken to show crystallization, miner's picks, and finished ax heads made therefrom, placed side by side. Jackson Sharp & Co., of Wilmington, Del., contribute some chilled castings broken to show drill, and some interesting examples of hardened cast steel on a central core of cast-iron. The Albany and Rensslaer Steel Co., contribute a handsome pyramid with base in form of a six-pointed star, exhibiting ingots and various uses of Bessemer Steel such as rails (twisted cold), and crow-bars, and the use of "crop ends" in the production of horse shoes, nails and rivets of various sizes.

These complete the steel manufacture exhibits; those of iron manufacture are simply confined to an exhibit in the New York case of magnetite, poplar, white birch, and black ash, (as samples of the wood made into charcoal) and the finished pig by the Convex Point Iron Co., Essex Co., N. Y. There are also anthracite pigs from the Cornwall Co., the various grades of Durham pig No. 1, 2, 3, and 4, Gray Forge, and mottled iron with an interesting specimen of "Mokra" ore from Algiers, Africa, and magnetite from New Jersey, contributed by Cooper, Hewitt & Co., and a trophy of galvanized iron and steel wires, and copper wire by the Washburn and Moore Manufacturing Co. of Worcester, Mass.; these complete the exhibits of manufactured iron and steel. The manufacture of lead also is indicated by examples of the sheets, pipe, and shot of all grades varying from dust up to F. F., and tin-lined lead pipe indicated in a trophy by Tathrow & Bro.

The production of metallic copper from various kinds of ores is shown by two exhibits, the one by C. M. Wheatley, of the Schuylkill Copper Works, Phœnixville, Pa., of copper silicate oxide carbonate and pyrites on magnetite, iron and copper pyrites mixed, and blocks cut from the vein matter of the mines together with full analysis, and the results of each of the fire smelting operations by which the metallic copper is at last obtained in a form ready for market. The analyses prove mag., oxide of iron, copper oxide, quartz and silica to be the chief ingredients of the ore and its general quality may be inferred from the two following condensed analysis, i. e.,

	1.	2.
Metallic Iron	39.38 per cent.	52.666 per cent.
Copper	1.246 "	.008 "
Phosphorus	.001 "	.002 "
Sulphur	1.076 "	4.549 "

The results of the fire smeltings are shown in copper motte from the first, blue metal from the second, white metal from the third, blister copper from the fourth, and the copper ingot from the fifth, with the slags from each. The other exhibit is that of the products of the Hunt and Douglas process by the Chemical Copper Co. of Phœnixville, Pa., and consist of specimens in glass jars of the treatment of chlorides, cabonates, silicates and sulphurets of copper.

The Lehigh Zinc Works have contributed good specimens of blende and calamine with spelter made from the same, and sulphur obtained from the blende; also they show the associate mineral, cryolite, and carbonate of soda, its product.

The pure metals, cobalt and nickel, are shown with their ores and products in the same case, by Joseph Wharton of Philadelphia. The ores consist of nickleferous pyrrhotite, millerite (nickel sulphate), and chalybite (carbonate of iron), and the products and uses are shown in handsome crystals of the various salts, nitrate, chloride, sulphate, ammonia-sulphate and oxide of nickel and nickel motte; and of cobalt the ammonia-sulphate, chloride, nitrate, and sulphate salts; the finished products comprise handsome specimens of both wrought and cast nickel, the 3ct. and 5ct. coinage with nickel 25 per cent., and copper 75 per cent., and a well glazed saucer colored with the deep rich blue of cobalt; this is a very interesting case.

Another case exhibits alloys of copper, zinc, and nickel of an interesting character, contributed by the Scoville Manufacturing Co.

Coal tar and its products are shown in a series of sample glass jars containing naphtha, gasolene, kerosene, benzine, astral oil, paraffine and colza oil, with coke and pitch made from petroleum. Clay and its uses are partially shown by a few specimens of raw material and pressed brick and fireclay by retorts and furnace brick made therefrom by Manhattan Fire Brick Co. Glass is shown by Wm McCully & Co.'s exhibit, of Pittsburg, in a case containing kaolin, fire sand, lime and rock sand, with their products in flint and opal glass, and also by a well arranged case showing flint glass manufactured from the quartz sand, Berkshire, Mass. A sample of quicksilver in a California case, the iron flask for its transportation weighing 76 lbs. when full, alongside the cinnabar ore, and a few pigs of iron, lead and copper in various cases complete the endeavors made to show the economic uses of the minerals in the collection; which endeavors it must be admitted are but partially successful, this being due to the want of comprehension on the part of certain contributors; however, in the continued perfecting process carried on by Prof. Blake, this deficiency and the want of analyses will be duly met, and eventually our national collection of economic minerals, their manufacture and uses, will be second to none in the world.

Turning now to the exhibits of building stones we find a large assortment of marbles, statuary, grey, red and black, from Vermont, a few from Tennessee, and two curious specimens from Montana, one of which is certainly misnamed. Of granite, Maine sends her well-known grey varieties, Massachusetts, grey and red, and a few other states, small samples. Limestone, both grey and white, from Pennsylvania, white crystalline from Connecticut, blue, grey and white from Massachusetts, and a few other specimens are shown as suitable for building purposes. Roofing slates from New York, emery rock (diasparc) from Massachusetts, a few ancient axe and arrow heads from Gen. Wilder's collection in Chattanooga, Tenn., septaria from Kansas, soapstone from Vermont, and phosphatic rocks from South Carolina are a few of the miscellaneous exhibits. Some very handsome and interesting specimens of rare crystalline minerals are to be found in a collection in two large cases compiled from the private collections of Rev. E. R. Beadle, T. D. Rand, Jos. Willcox, W. W. Jefferis, Geo. R. Kœnig, all of Philadelphia, or vicinity, and lent to the present exhibition.

Prof. Hitchcock exhibits the geology of New Hampshire very plainly by a collection of the various rocks, and the Philadelphia & Reading R. R. Co. show the coal strata about Pottsville bs a plan and section of two colliery shafts, a model of machine for cutting marble, another of a Blake's crusher, section of an artesian well, and large geological maps of Maine, New Hampshire, Massachusetts, Connecticut, Vermont, Alabama, the Chattanooga district, Tennessee, and a geological map on a scale of 16 miles to the inch completes the miscellaneous exhibits. To give some idea of the magnitude of this collection the writer has computed the area of surface covered by the exhibits from the different states. It amounts to about 3250 sq. ft., in detail as follows:

Arizona	36 sq. ft.	Nevada	810 sq. ft.
California	256 "	New Jersey	108 "
Colorada	72 "	New York	72 "
Idaho	72 "	Oregon	4 "
Montana	152 "	Pennsylvania	108 "
Michigan	144 "	North Carolina	72 "
SouthC arolina	36 "	Tennessee	252 "
Utah	140 "	Virginia	39 "
West Virginia	36 "		

Loan Collection of choice crystalline minerals.....304 sq. ft.
Marble, granite aud stone from Me., Ct., Vt. and Mass. 300 "
Large masses of ore from all the Rocky Mountain states and territories.....260 "

There are nearly 30,000 different specimens, and the bullion value of the metals in the ore is not less than $50,000; by reason of the variety of some of the samples of course the actual value of the collection is considerably above this figure.

The American Institute of Architects.

The chief attention of the late Convention of American Institute of Architects was given to the questions of fees and of membership. It was felt on all hands that for the work the Institute was to do, as well as for its own prosperity, it was important that it should engage the co-operation of as large a part of the profession as possible; and co-operation means membership. Whether the reduction of fees will prove the widely prevailing inducement that many members expected, we are somewhat disposed to doubt; although, apart from the fact that economy is desirable for its own sake, so far as it does not interfere with efficiency, it is worth while to try the experiment. Setting aside the straightened feeling that is peculiar to years of business depression like this and the last, architects would probably be willing to pay the moderate sum which has been required of the members of the Institute when-

ever they took a real interest in the objects for which it was demanded, and saw that their advantage and that of the profession were promoted in them. It is the policy of the Institute, therefore, not merely to make the financial burdens of membership as light as they may reasonably be, but to show that its work and influence are useful, and to give evidence of such interest among the members as shall excite interest in others. It is not enough for the members to be apathetically persuaded that its fellowship is a good thing, to be enjoyed in contented inactivity; it is not enough to make it easy to come into it: it must be shown to be desirable also. For a membership that is purely ornamental, men may be willing to pay a little, but it it will be only a little. As soon as they see that it forwards objects that they have at heart, a larger payment is a readier contribution.

Some members have been disposed to ask (rather inconsiderately, it seems to us) what they get in return for their annual fees; and outsiders may more naturally ask the same question. A diploma of fellowship, and an annual pamphlet of more or less interesting proceedings, are no great return, certainly; but a professional association is neither speculation nor a gift enterprise. The real question is not, What visible return can the individual contributor show for his money? but, Are the objects for which it is spent worth the while, and is it spent upon them with proper economy? And prope economy is not screwing down the expenses to the lowest point, but taking care that nothing is spent except for a reasonable want. The work of the Institute is the improvement of the standing, influence, and efficiency of the architectural profession in the United States. Its benefits cannot be parcelled out and estimated for individuals; but they are real and weighty, as will be evident to anybody who will take the pains to examine the record of the past twenty years; and they are shared by the whole profession: hundreds who have never lifted hand to help the work owe some part of their every-day success to what the Institute has done. The independent position of architects, so far as it is independent; their recognized property in their own designs and drawing; their repute in the community; their acceptance as experts in the courts; their security in demanding the customary fees,—all these owe their establishment in a good degree to the Institute, which has fought many a hard battle, and gone through much laborious work, in their behalf. The building laws of our large cities, imperfect as they still are, have been made as good as they are through its efforts. The determination of innumerable questions of practice has been helped by it; and it has done a good deal to keep up and display a high standard of attainment among the profession. In other words, so far as association and common endeavor have done anything for architects in the country, it is due to the Institute; and, for whatever may be accomplished by these means in the future, the Institute is to be looked to; for there is no other such organization, and none other is needed. That there is work enough to be done which requires common and organized endeavor, ought to need no argument; and that fellows in work are mutually im proved by association and the widest interchange of ideas, is as evident. The good effects of professional association are patent to us in the two professions which are at present the most respected and the most progressive among us,—the medical and the engineering. The remarkable progress in enlightenment and influence of these two professions, of late years, is very greatly due to their associated activity; and it may safely be said that the cities in the United States where architects are most useful and most respected are just those in which their association has been the most active.

There are those in every profession who are content to share the benefits of others' work, and contribute nothing to it; who will reserve their own efforts for what personal success they may control, untrammelled by the obligations of societies, while they draw their profit from the standing of a profession which their irregularities tend to undermine. There are others who would deliberately prefer a life of outlawry, in which their hand should be against every man; but their ways, if they should prevail, would speedily reduce the profession to the condition in which it was a generation ago, when, as a profession, it had no respect at all in the community, and would make the general practice an unseemly scramble for patronage—a chaos of underbidding and bad work. There is enough hard work to be done in architecture without wasting strength in pulling down one's fellows, or undermining the platform that supports the whole, for the sake of raising a solitary pier for one's own support. However capable a man may be of standing alone, there is nobody to whom the good repute of his profession will not be an efficient help. This repute depends much more on the average attainment and received standard of the profession than on the exceptional qualificatians of individuals; and there is nothing that raises the general level of attainment like associations. The mass of any profession will gain more by the support it will give them than they will lose by any small surrender of independence that it may exact. Professional independence, in fact, is impossible. There is no such thing. Every architect learns from his fellows, and is sustained by them, as every physician does, or every engineer; and an honorable man will be glad to give as much as he gets. The question is, whether one shall take what he can without acknowledgment and without return, or shall make his contribution for the general good; whether he shall thrive by blackmail, or by exchange.

Those who take the selfish view of the question will look only for personal return; but it is well, even then, to take in the broad aspect of it; and, in the broad aspect, whatever is best for the profession is best for the individual. Whatever abridges the necessity for self-defence leaves so much more energy for advance. Where the establishment of a recognized system relieves a man from the necessity of fighting for his fees or his authority, or for advantages over his fellows, he is so much freer to put his strength into his work. When the community has learned to understand and respect his profession, he has exactly the same kind of advantage that accrues in society to a man whose social position is assured. But, happily, the majority of architects have other than a personal interest in their profession. They are fond of their work for its own sake, and wish to see the general standard as high as possible. They are desirous to educate their communities to the understanding of good work, and to lift their profession to a high level. These men the Institute wishes to attract to itself: they, if they will realize it, will find the Institute an invaluable means to their ends.

The policy of the Institute is as far as possible from being exclusive. Its only condition of membership is "the honorable practice of the profession." Its standard of honorable practice is the same that is maintained everywhere, by architects who respect themselves and their vocation, both in this country and in Europe. To the younger architects, especially, the Institute should look for support. The future of the profession is in their hands. Their opportunities of attainment are better than those of their predecessors; they have the freshness of interest that belongs to the beginning of a career. It is of the first importance that it should attract them to itself by giving them an example and encouragement to attainment and culture, and by laying before them work which they can attempt with interest; and they should look upon it as having privileges of value to confer, and a helpful support to give,—still more as a valuable instrument for the accomplishment of the many objects they will have at heart for the good of their profession.—*The American Architect and Building Journal.*

Lessons from the Centennial.

Every intelligent man while examining the Exhibition will do so with this thought in his mind, "What may we as a people learn from this?"

We first get an idea of America's true position among the nations of the earth such as we never had before, we see the relative value of our exports in the countries to which they are sent; we see the differences between the various articles of trade, commerce, manufacture and industrial art as designed and produced in foreign countries and those of our own; we see the results in other countries of the adoption of diverse policies (free trade or protection for example,) and the effect of modes, forms, and systems of government upon the great manufacturing, and also upon the art industries of a country; and as *one* of the practical results of careful observation we ascertain in what directions our future enterprise may extend outside the confines of our own shores.

To one who knows of the surprised expressions of European engineers who have visited America in numbers, this year, at finding evidences not only of originality but of care, system and economy, in some branches of American engineering, it would appear at once most feasible and promising of success to introduce into Europe some of our specialties in system and manufacture which, on comparison with analogous ones of other nations, are found superior. Take for example the American system of iron bridge-building, "spider-like," as it has been termed, yet perfectly safe and from 25 to 40 per cent. less in cost than the general systems in modern use in Europe. Will not some of our great bridge companies, such as the American of Chicago, Keystone of Philadelphia, Phœnixville of Philadelphia, Detroit Bridge Works, etc., etc., reach out their feelers into the European market and tender there, for contract?

The writer firmly believes, that taking into account all the disadvantages of freight charges for so long a distance and other drawbacks, an ordinary railroad bridge on the American system, designed and constructed here can be erected at about any site in Europe, at a less cost than one designed and erected in the immediate vicinity of the site,—and if in Europe, then the world over. It seems at first sight almost advising the "carriage of coals to Newcastle," to advocate the extension of American engineering into a continent which is the very birthplace of our profession, but appearances and observations would fully justify at least an attempt in that direction, and a personal reconnaisance of the field suggested, on the part of some of onr manufacturers.

As regards machine tools, an inspection of the exhibition justifies the inference that most nations at present are supplying their home market with the machines best adapted to home uses, though a few of the smaller American machine tools and some of special makes have won a place in the British, and other foreign markets; and most probably the consideration than American manufactures in this line are best adapted to American wants, is the cause of so small an exhibit of machine tools being made by foreign nations. Several of the best known names of British makers are entirely absent.

In hand tools America can undoubtedly congratulate herself on being first; indeed a demand for some lines of them has already arisen in England, and in the Australian markets they are very generally preferred.

And this mention of Australia leads us to the consid eration of that continent as a field for American enterprise. Of all the countries represented at the Centennial, none impresses one so much with their enterprise and apparent substantial vigor and prosperity, as the colonies of Australasia. Four of the five colonies on the mainland, South Australia, Victoria, New South Wales, and Queensland, and the two island colonies Tasmania and New Zealand are all well represented, and a slight inspection of their various records show the rapid and substantial progress made by them since their first settlement. Victoria is the only one that has adopted a heavy tariff on imports, done professedly for the encouragement of home manufactures, and the tariff in the other colonies does not include articles which any of our machine manufacturers produce, such as wood and iron working tools and machines, agricultural machinery, windmills, iron in sheet, pig, or bar and other useful and precious metals, all which are imported free. There is thus an open field for foreign enterprise, and it is to be hoped some of our manufacturers will recognize that it is to their interest to exhibit at the approaching Exhibition in Sydney, New South Wales, which opens next April.

The Empire of Brazil has ably put forth her claims to consideration as a field for the employment of American capital in its development, but money from this country is already invested in Brazilian enterprises which are not so successful as could be wished. On the whole, we decidedly recommend the earnest attention of capitalists and manufacturers to Australasia, especially the two northern colonies of New South Wales and Queensland, the latter of which is a large tin-producer, a metal which, with the exception of a small deposit in California, is entirely absent from this country.

A few words on America's position with respect to applied art, though not perhaps pertinent to the scope and object of the NEWS, will probably be of interest. Industrial art, that is, the application of artistic designs

to pottery, glass, gaseliers, wall-paper, damasks, carpets, furniture, etc, is *the* line at the Exhibition in which America shows to the least advantage, and has most to learn from foreign nations, and indeed, the best American exhibits of this class show very plainly the hands of foreign designers. Our technical schools of art, such as the Mass. Institute of Technology, show some progress, but we are yet far behind other nations in the knowledge and practice of art principles by native American artifices, and where attempts have been made to imitate a national style, they are, with the exception of some of Tiffany's, of the crudest description.

Two more lessons may be learned tending towards a better representation at the next Industrial Exhibition. First, that the average visitor to the Centennial does not understand the great majority of the objects he sees. Such a visitor on being interrogated, "Understandest thou what thou seest?" would in all probability reply "How can I except some one explains unto me?" and this consideration induced the writer to propose a series of popular lectures, to be given during the progress of the Exhibition, in the city of Philadelphia, by well-known experts in various branches of art (pure and applied), science (pure and applied), and manufactures; the lectures to be illustrated by reference to the objects shown in the Exhibition, so that a man attending a lecture on a certain evening could next morning verify the lecturer's remarks and conclusions by personal examination. The exhibitors by thus having an *intelligent* interest drawn to their exhibits would feel all the more certain and sure the advantages of the Exhibition. Gen. Chas. B. Norton, Chief of the Department of the Press in the Commission, entered into the scheme heartily and favored its immediate inauguration, but the members of the Pennsylvania Museum and School of Industrial Art, under whose auspices it was proposed to inaugurate the course, considered that the time was too short (they were proposed about the end of September) and the chances of a profitable audience too uncertain to warrant the expenditure necessary to carry them on. So the scheme was dropped, but it is well worthy the attention of those who have the management of all State, National, or International Exhibitions.

Another thought brought prominently before an intelligent observer is, that with very few exceptions, processes of manufacture are most inadequately represented. We find here and there throughout the vast area covered by the Exhibition samples of raw material, and in other places finished products, but very seldom do we find the two brought into juxtaposition, separated only by the various stages of the processes by which the one is transformed into the other. To give a true and perfect representation of the present state of national industries and manufactures this should have been carried out in this exhibition, and we are glad to find that Gen. Norton is energetically moving to have American industries and manufactures represented in this complete manner at the next International Exhibition at Paris in 1878—a scheme which he was the first to propose, but failed to carry through at the present exhibition. As mentioned elsewhere in the NEWS, Prof. Blake has initiated this scheme in the National Museum Geological Collection, but through failure in intelligent co-operation on the part of many of those to whom he applied for exhibits, the idea has been so far but partially carried out.

American engineering, as a whole, is insufficiently exhibited either by government or by private effort, and Gen. Norton is also interesting himself in obtaining proper representation of our profession at the Paris Exposition of 1878. It seems to the writer, that the American Society of Civil Engineers, and the American Institute of Mining Engineers, the two representative societies of the country, should combine their forces and endeavor, in the interests of American engineering as a whole, of American industries, and American manufactures, to secure from Congress during the coming session an appropriation sufficient to show, by means of carefully executed drawings, models, etc., a representation of our nation in those directions as nearly *perfect* as possible, and in the manner shadowed forth in the preceding remarks. C. J. MOORE.

Correspondence.

FULTON, MO., *Oct.* 2, 1876.

EDITOR ENGINEERING NEWS:—The falling of the line between sections 19 and 30, T. 48, R. 8, W. 5th P. M., is 238 links south. The corner to 24 and 25, T. 48, R. 9, W. has witness standing; the corner 238 S. is lost. A former county surveyor established without witness the corner—between sections 16 and 30,—400 links south, and surveyed off 12 acres in the N. W. ¼ of section 30, "beginning at the N. W. corner of 30, thence S. ½° W.—14.35 chains"—etc., describing the boundary of the 12 acres. What would be the legal way to find the area of the N. W. ¼ of section 30, less the 12 acres.

Are the decisions of the Supreme Court in Land Suits published in any separate volume. T. H. H.

Ans.—We would establish the *correct* N. W. corner of section 30 by the "witnesses" and the "falling," and after obtaining the *correct* area of the N. W. ¼ of the section by the usual method, deduct the 12 acres. To stake out the 12 acres, follow the description as given in the deed. The decisions of the Supreme Court in Land Suits are published only in Vols. I and II of ENGINEERING NEWS.

Water Works, Ancient and Modern.*

BY E. H. D'AVIGDOR.

(*Continued from page* 352.)

The tunnel was commenced in the autumn of 1869, having been sublet to a local contractor; this man undertook the work without being by any means equal to the task. He never put enough men on, used ordinary gunpowder only for blasting, and neglected anything beyond the usual rule-of-thumb precautions for short tunnels. Finding his progress so unsatisfactory, that, at the rate at which he carried it on, the tunnel would have taken six years to complete, Mr. Gabrielli took it out of his hands and attempted to continue the work by day labor. At that period, 1870–71, the demand for labor generally, and particularly for miners and quarrymen in Austria and Hungary was enormous; railways were being taken in hand in every part of the country, and local labor which in South Austria and Hungary is quite insufficient even for ordinary requirements, owing partly to the sparseness of the population, but still more to their ingrained and insurmountable objection to anything except desultory work, had to be very largely supplemented by heavy draughts on the frugal, industrious, and ingenious population of Northern Italy. These men come into Austria in the spring in numerous gangs, and invariably return to Italy with their savings in the autumn; it is very difficult to induce any of them to remain to face the severe winters, when ordinary railway work must necessarily be suspended for several months, and in fact hardly any masonry is ever executed between November 1st and March 31. Even the miners generally decline to remain during this period, and the few who were persuaded to stay in Austria find constant employment at very high prices on the railway works everywhere. It was absolutely necessary to push on the Kaiserbrunn tunnel winter and summer, day and night. On the other hand the Italians had an immense objection to working in the confined section of the aqueduct; they were used to piecework in railway tunnels, where after the first drift they could stand upright and had better ventilation and plenty of room. It was found quite impossible to keep a number of good gangs together in the remote cold valley of the Schwarzau to work in a narrow cramped tunnel. In this predicament the contractor applied to the Austrian War Office for the services of a detachment of the Imperial Engineers (sappers), who were at that period being drilled in the use of miners' and quarrymen's tools, and in blasting with dynamite, This request, supported as it was by a petition from the municipality, was granted, although on onerous terms to the contractor, who had to pay about 12s. 6d. per yard of stuff excavated, to consent to a considerable increase for all leads above 20 yards (amounting in fact to about ½d. per yard moved per yard run), to erect substantial barracks for the officers and men, to supply all plant, material, fodder for the horses, etc., and finally to take all responsibility as to the result upon himself. The detachment, which at first consisted of but one company, was gradually increased to 213 men. They commenced work on the 14th of January, 1871, and pushed it on with great energy and endurance. In May of the same year 400 yards were driven, and the contractor, who had up to this period continued to employ such Italian miners as he was able to get on other sections of the tunnel, made arrangements with the Imperial Engineers to execute the whole of the work. Exactly one year later, on the 4th of May, 1872, the whole of the tunnel was driven, and all the sections had been joined without any divergence or mistake in the line. Altogether 2100 yards were driven by the sappers in twelve months; but it must not be forgotten that they were constantly supported by a numerous body of Italians who ran the stuff out, erected temporary bridges, made the roads up, and in fact did all the odd jobs inseparable from so large an undertaking.

The explosive material used for blasting was exclusively dynamite, and its use was found to be much more economical and much safer than that of gunpowder. The cartridges were composed of 70 per cent. of nitroglycerine, and 30 per cent. of neutral substances, mostly sawdust; they were 9-10 inches in diameter, and from 1 inch to 4 inches long. The cost of the dynamite cartridges was about 1s. 10d. per pound, English, and the weight of each was from 2 to 5 ounces, according to length. The ordinary Brickford's patent cord was used for ignition, except in wet places, when the cord was surrounded by a coat of gutta-percha. At a later period a capital effect was produced by the use of electrical apparatus for firing a series of boreholes simultaneously. It would take up too much space to enter into all the details of the interesting experiments on the use of dynamite which were made in the course of the work and the results of which were carefully noted by the Imperial as well as by the contractor's engineers; they may be reserved for a future occasion. But two points must be mentioned. Dynamite is very liable to freeze, and when frozen is extremely brittle, and therefore liable to explode; a special hot-water apparatus was therefore contrived to thaw the frozen cartridges, and in the winter a responsible non-commissioned officer was charged with the special duty of seeing that no frozen cartridges were sent into the tunnel. Again the immense advantage of dynamite for fissured rock was ascertained beyond the possibility of a doubt. In such a material the gasses developed by the explosion of gunpowder frequently escape through the cracks, because the ignition of the gunpowder is not instantaneous; the effect of a shot is, therefore, often almost *nil*. Dynamite, on the contrary, explodes instantly, and works in a complete sphere, of which the cartridge is the centre; the gasses have no time to escape through the cracks, and the effect produced is proportionately greater. The advantage of using dynamite in wet places is too well known to need explanation. A well greased cartridge exploded in a bore hole plugged with water, produces as much effect as if it were in the driest rock, and had a clay tamping. Although the heaviest portion of the work was finished as above described in May 1872, much still remained to be done. The floor of the tunnel had not been carried down to the full depth everywhere, since before the junctions were effected all the drifts had been driven with a rising gradient to get rid of the water; the excavation of the few inches still remaining was a tedious job, and had to be done by daywork. In some places considerable springs were tapped; here recesses in the tunnel were blasted out, and an apron of masonry constructed in front of them, forming a little reservoir or basin, from which the spring water overflowed into the tunnel. And the most difficult part of all was the connection of the upper end of the tunnel with the Kaiserbrunn spring itself. For of course the invert was at this point (Station O) considerably lower than the existing bottom of the spring; the blasting and excavating to within a few feet of the spring was done in open cutting from 16 feet to 30 feet deep, and three portable engines, of a combined power of forty horses, were used to pump out the water with Woodford's centrifugal pumps. This work was done, and the masonry canal constructed in the summer of 1872.

The portion *a c* having been at last completed, the work in the very body of the spring had to be commenced, and as it was found impossible to tap the spring at a higher point and get rid of the water by a temporary cut, a large shed was erected over the whole place to protect the men from the inclemency of the weather, and the engineers proceeded to bore holes in the floor of the rock under the rapidly flowing water and to blast it out with dynamite. On this occasion the enormous advantage of electrical ignition was evident, as by firing 10 to 12 holes at once an immense surface was started, and the *debris* could be removed very much more rapidly than if the firing had taken place by the ordinary methods. The sappers worked in gutta-percha boots which reached up to their thighs, and the temperature of the water being seldom above 40 deg. and often down to 38 deg., they had to be relieved every two hours. As soon as the excavation was completed a cofferdam was erected across the square forming the plan of the reservoir, and the water pumped out of one-half, while that in the other was carried off through the completed canal. Thus the masonry of ashlar was rapidly run up, and in the course of the winter and early spring was carried above the water level. The crack through which the water escaped from the rock was further excavated and enlarged, which led to the discovery of a cavern running some 60 ft. back into the rock; this was also enlarged and partly lined with aprons of masonry to prevent the water escaping through small cracks in the rock itself, and thus formed a sort of inner reservoir or catch-water basin.

(*To be continued.*)

* A course of papers delivered at the Austrian Institution of Engineers and Architects, December, 1875, and January, 1876.

APPRENTICESHIP AND INDUSTRIAL SCHOOLS.

The present practice in large machine shops is not favorable for the education of master workmen. Where a large contract for machines of any kind is taken, or a number of parts have to be made, the aim is to have as much done by the machine tools, and as little by hand, as possible, reducing the amount of fitting-up to a minimum. For example, in gun work, the parts of one arm are interchangeable with those of another of the same pattern; the same thing is true with good sewing-machines, and in fact with all the articles which are produced in quantity. The forgings as far as possible are made by dies, the drilling and turning, the planing and shaping are done on machines arranged with stops and guides, and tested by gauges, so that no careful attention is necessary after the tool is once set. Then the use of milling machines enables one to produce surfaces more or less irregular, which would once have been roughed out as well as finished by the file. Indeed much of the filing is done when the object is clamped in a templet or form, so tnat it must be perforce brought to the desired shape.

The ordinary workman then may tend a lathe or planer, or may file at a vise, repeating the same or similar processes for months, earning fair wages and turning out an immense amount of work, as he naturally acquires a certain amount of dexterity in a specified operation. Even the fitter assembles the same pieces, and goes through the same manipulations from day to day in one narrow round. There is employment for a few men who sink the dies, make the templates and gauges, lay out the work in the beginning, and repair such tools as require it. Boys are put at work tending screw and nut machines or lathes where the operations are entirely mechanical. Where then, among the hundreds of men often employed in our large shops, will you find a sufficient number of boys who are so employed as to have any instruction in the rudiments of a machinist's trade, or any probable chance of learning the different ways of manipulating iron, steel and wood, from the raw material to the finished product? A sufficient number we mean, to replace the men who from time to time retire by reason of old age or other disability.

One of the smaller shops, where a considerable variety of work is undertaken, offers much better facilities for the young learner, but, even here, boys under systematic and definite instruction are not so frequently to be found as is desirable. The system of apprenticeship seems almost to have gone out of vogue. The old-fashioned seven years term, which our elders had to serve, and which gave ample time for the pupil to become a thorough and skilled workman, was much too long for our restless American youths, and even the short period of three years, scanty time as it is for accomplishing any good result, seems long to the shop-boy, when he might be tending a machine or working at piece-work for himself in such establishments as we first referred to.

The attention of many has already been directed to this matter; a New York paper lately said:—

"All who have given thought to the subject are aware of the extent to which all trades and occupations are drifting into the control of large business concerns, and how entirely the system of apprenticeship has died out. We know how difficult it has come to be for a boy to acquire thorough training in, and mastery of, any recognized mechanical occupation."

Even if some improvement of the existing condition of things could be brought about within the shop, we are met by another and quite different obstacle in the Trades-unions and their exactions. Among other restrictions which they seek to enforce and which they generally succeed in carrying out, is one limiting the number of apprentices which shall be employed. The object is of course to keep up wages by diminishing the amount of material from which the employee can draw his supply. The editor of the *Co-operative Journal of Progress*, of Louisville, Ky., reputed a careful and cautious statistician, says:—"The selfish action of trades-unions is making a cruel war upon posterity, by prohibiting apprenticeship to a degree dangerous to our country." He further illustrates this point, and then suggests the remedy which seems to us at once feasible and entirely satisfactory. "In Pennsylvania, at present, which is probably no worse than other states, the number of apprentices is less than one-fourth of the number required to keep even the present inadequate supply of of skilled labor, and unless this adult monopoly can be broken up there is little hope in our country's future except in *industrial day schools, in which all the industrial arts can be more thoroughly taught* than they are in the usual demoralizing and unscientific training of apprenticeship."

Such schools we can have, and indeed a beginning in this direction has been made in this country. In Europe systematic instruction of this kind has been carried on for many years. Prussia has had industrial schools in operation for three-quarters of a century; the city of Berlin has thus constantly in training not less than eight hundred apprentices. The cities of Germany have also been working in the same way, though not for so long a time. In Sweden, France, Russia and Italy are to be found such combined schools and workshops, where the trade is acquired and the education carried forward at the same time.

Men educated in this manner, acquainted with the various operations proper to their trade, and, what is better, informed thoroughly as to the reasons why one way is adopted in preference to another, well grounded in the principles of science, will not receive and transmit the crude notions and customs which have prevailed among so many artisans. That the instruction shall be of the best character, and eminently practical, that the work-room or laboratory shall be side by side with the school and lecture-room, is of course necessary. With care and experience, the attainable results are admirable; indeed, a systematic arrangement of the instruction brings about such a saving of time that the pupils will far outstrip any apprentices in the best arranged shops. What may be accomplished by this means, in machine work, has been shown to many of our readers, at the Centennial Exhibition, by the exhibit of the pupils' work from the Imperial Technical School of Moscow, displayed in Machinery Hall. A young man who has performed understandingly the various tasks whose results are here to be seen, is well qualified as a master machinist.

Not to dwell on this important subject at too great length, we will postpone until next week an abstract of the course of training in this Russian school. Suffice it to say that should each state or large city see fit to establish such schools, the common people, when once they understood the aim, would willingly give for their support the taxes which they now grudgingly are obliged to pay towards the purposes of higher education in our high schools.

Elevation of Lake Michigan for 1876.*

MONTH.	Max.	Min.	Mean
January	1.80	0.60	1.26
February	2.50	0.40	1.55
March	2.83	1.30	1.87
April	2.90	1.37	1.92
May	3.50	1.00	2.68
June	3.50	2.60	3.05
July	4.20	2.80	3.43
August	3.70	3.00	3.38
September	3.70	2.50	3.31
October	3.70	1.60	2.63
Year (thus far)	4.20	0.40	2.50

WEEKLY MEANS (JULY, AUGUST, SEPTEMBER, OCTOBER.)

Week ending July 8	3.29
" " " 15	3.59
" " " 22	3.44
" " " 29	3.34
" " Aug. 5	3.47
" " " 12	3.32
" " " 19	3.47
" " " 26	3.30
" " Sept. 2	3.30
" " " 9	3.41
" " " 16	3.45
" " " 23	3.36
" " " 30	3.18
" " Oct. 7	2.66
" " " 14	2.65
" " " 21	2.56
" " " 28	2.60

*Above "Chicago Datum," which is 1.805 below the mean water of last 22 years.

The unusual hight of water this year has been referred to in previous issues (Sept. 2d and July 29th). The water has receded about .8 ft. since July but is still .7 above the average for October for 21 years. On Oct. 14, 2 a. m., the waves were reported as running 12 feet high, by the crib keeper: this was probably the severest storm of the year as more destruction or washing away of shores took place than during the whole year beside. Whether occasioned by high water or other causes it has become quite apparent that the usual protection hitherto relied on for our shores; viz., jetties or spurs at right angles to the shore spaced apart by about three times their length, have quite failed, the deposits between being carried away and the shore attacked as fiercely as in places where they do not exist. This problem* which was supposed settled by the experience of the Illinois Central Ry. Company, who have had a long extent of lake shore to protect for the past 20 years, is again in a greater state of uncertainty than ever, and it is quite doubtful if anything is reliable except heavy works, parallel to the shore, of double rows of piles filled in with stone in depths of less than 8 feet and of crib-work in greater depths. This is quite expensive and some comparatively cheap method for securing our shores permanently is now a greater desideratum among riparian property holders than ever.

WE are pleased to see the prompt response from the engineering and medical professions which our new enterprise in re-publishing such a valuable and expensive work as Latham's "Sanitary Engineering" is eliciting. Already our subscription list is very materially increased and we have no doubts as to the result. Such an undertaking has never before been attempted in technical journalism, but knowing the desire which exists to get access to this class of books, and which is debarred by reason of the great expense, we feel certain that the above professions will liberally sustain us in our efforts to bring such information to them at such a trifling cost as we are now doing it.

OUR friends will please to bear in mind that no additional charge has been made for "Sanitary Engineering," although a great many expensive tables and illustrations have to be got ready as rapidly as we can prepare them; we propose in fact to present a *twelve dollar* book of genuine value to all our readers, in addition to our usual weekly paper; we hope our subscribers will make an extra effort to bring our paper to the notice of all their friends and so encourage us to attempt even greater things than we yet have done in engineering journalism.

THE materials used in the construction of sewers are bricks, tiles, stone, stoneware, asphalte, cement, concrete, iron, and timber. These will form the subjects of a pretty long chapter in our publication and we invite immediate correspondence in relation to them. We hope that parties interested in the subject of sewerage will give us descriptions of the methods adopted *in this country* in the manufacture and use of the above materials and by this means assist in making our subject one of great interest to a large range of readers.

THE AMERICAN BRIDGE COMPANY'S ALBUM OF DESIGNS.

We are in receipt of this handsome collection of plates which illustrates very fully the practice of the American Bridge Co., and the numerous special features of construction which they have so successfully introduced, we may say, to give American Bridge Engineering much of its distinctive features as a national system, and toward which foreigners in this Centennial year have exhibited nothing but admiration for its graceful simplicity, and economy as compared with their own structures.

The American Bridge Co. are too well known for us to speak extendedly of their works. Suffice it to say that a majority of the large bridges of the country have been constructed by them, both the Mississippi and the Missouri rivers being almost exclusively spanned by their structures.

The album itself consists of about 40 pages, 15½ x 20½ in., of which there are 7 pages of text and 28 full page plates, with several perspective views.

We learn from the Album that the construction of railway bridges on an extensive scale was commenced by A. B. Stone and L. B. Boomer, in Chicago, in 1851. Subsequently this firm was merged into the present company of which P. B. Stone is President and H. A.

*The jetties or spurs were successful with the above company for about 17 years, but during the past 3 have failed them quite entirely. This may however be due to the construction of the government breakwater, against which the prevailing winds and waves strike at an angle and accumulating force as they move southward shear off the end to impinge directly against the shore. The jetties or spurs however have failed all the way up the shore during the present year, in greater or less degree, so that the causes are not wholly local.

Rust, Vice President and General Manager in Chicago, the place where the works are located. The company own 32 acres of land well located at the city limits, near the tracks of the Pittsburgh & Fort Wayne and the Michigan Southern railways. Side tracks aggregating 2 miles in length make available the numerous railway connections at this point.

The buildings are as follows: — Machine shop, 84′x 420′; Hammer shop, 60′x140′; Blacksmith shop, 80′x 140′; Foundry, 80′x140′ and 50′x115′; Pattern shop, 80′x80′, and miscellaneous buildings, all supplied with proper plant for the work in hand. Beside the plant here we believe the company possess the only adequate plant in the country for dealing with pneumatic substructures.

The company are at present engaged on structures in 15 States, employing over 1000 men. The aggregate length of railway and highway bridges thus far constructed is about 239,000 ft. or more than 45 miles. The data in regard to their structures is presented in a large table.

Among the most notable structures now in process of construction is the Poughkeepsie Bridge, and the Point Bridge at Pittsburgh, Pa., illustrated in our issue of July 8, and chiefly interesting as an example of a new and useful type of rigid bridge for long spans, and reflecting much credit on its designer Edward Humberle.

Of the Poughkeepsie Bridge we shall give further details in a future number.

The LaCrosse Bridge, at present under way, illustrates the capacity of this company for quick work. It consists of five 150 ft. spans; extending from the Wisconsin shore to Minnesota Island and of two 164 ft. spans, one 250 ft., and a 360 ft. pivot span over the main channel from the Island to the Minnesota shore, or a total length of iron superstructure of 1678 lineal feet. Work was commenced on the superstructure in the shops in the middle of August, aud trains will cross the bridge on Dec. 1.

The Omaha, Leavenworth, Boonville, and Atchison bridges over the Missouri river are well known; and lastly the founding of the Fall River piers, one of them sunk 90 ft. in 60 ft. of water, and a heavy tide-way, being an extremely interesting example of the capabilities of the pneumatic process as applied to cylinders.

The plates illustrate the elevation, plan and details of standard structures built by the company as follows:— Wooden bridges; combination, or wood and iron; iron bridges; draw bridges; viaducts; piers and foundations; roofs, etc.

We believe this company have constructed the longest pivot spans yet built and their end adjustment is exceeded by none in efficiency. It consists essentially of screw and worm gearing, worked by engine or hand-gear at centre of bridge. An indicator shows exactly how much the ends are lifted, making it practicable to bring the bridge under the conditions upon which its calculations are predicated.

Every student of bridge engineering should possess this album, as it presents in a convenient form for reference some of the best examples of American bridge engineering as built by this company.

Albums have been issued by other bridge companies which are valuable for reference, but we have seen none previously in which the details were shown in sufficient size to give a comprehensive idea. We are sorry that there are no scales on the plates by which to measure the dimensions. This is probably an oversight.

NEWTON'S HYDRAULIC DREDGE.

We remember no recent engineering invention that has been so bold a strike forward, so radical a depature from established methods, withal based on principles well known, as that indicated by the heading of this article. Nearly all the improvements of the present day are mere matters of detail. modifications of ideas previously in use for a similar purpose, and it is seldom that we see elements combined to accomplish results in a manner radically different from existing devices.

The wonderful results accomplished in disintregrating and removing material by "hydraulic mining," i. e., the employment of jets of water under considerable heads, directed against a vertical face or slope of earth, is well known in mining districts; imagine jets of water under varying pressures up to 300 lbs. per sq. in., directed against the bottom or bench to be dredged, a pipe opening directly back of the jets through which flows a current of water of 30 to 40 ft. per second, carrying excavated material and water to the surface through the vacuum cylinders and out through horizontal piping to a dumping scow or to any desired distance inland, and you have the essential ideas; viz., a powerful jet to excavate and a swift current to transport to a distance the excavated product.

The present article is suggested by the numerous inquiries which have been received from all parts of the country, the great interest taken in it by foreign engineers visiting this country, many of them having visited Chicago with the purpose of viewing the one in operation, and the construction of a new and powerful dredge for the Texas Hydraulic Dredge Co., for operation in and about Galveston harbor.

In our issue of April 22, we gave a digest of the principles involved together with a description of the first dredge constructed under Mr. Newton's patents for Mr. O. B. Green, Contractor, in this city. In the issue of May 27, we gave a farther and more detailed description, illustrated by a cut, with an account of its practical operation. Our views then, as may be inferred from the articles referred to, were exceedingly sanguine as to the value of this improvement, and the practical operation of the dredge during the summer and autumn have more than confirmed all our anticipations. As was to be expected, its operation has suggested and necessitated changes and improvements, but the result of the season's work has confirmed our statement of April 22;— This dredge appears to solve the problem so long desired, of an efficient and cheap mode of dredging that must prove of great value, combining as it does, strength, simplicity, efficiency and economy of operation and repairs, with capacity to raise and convey by one operation, far in excess of the most costly dredges now in use.

Without reviewing the results obtained by the old dredge and the principles involved in its construction at greater length, we think a description of the dredge now constructing at the Vulcan Iron Works in this city together with the results expected, based as they are on previous experience, will be sufficient to make its construction intelligible and bear out our statements as to its efficiency.

The essential parts of the machine may be embraced under the following heads: 1, a wooden hull, 80x30 ft; 2, two boilers for supplying steam to the vacuum cylinders and the pumps; 3, a Blake pump for supplying the jets and water for condensation; 4, the two vacuum cylinders, operating in a manner similar essentially, to the Nye pump, the valves however being modified for this special work; 5, the telescopic section pipe with its jet attachment; and 6, the discharge pipes, etc.

The hull is to be built by the dredging company at Galveston, Texas. It will be 80x30 ft. by 8 ft. deep over all, with scow bow and perpendicular sides and stern. The bottom will consist of strong 12x12 in. timbers of Georgia pine running longitudinally and transversely and notched together so as to make a close and very strong rectangular framing to which the bottom planks are spiked, the sides and ends are wholly composed of 9x9 in. Georgia pine timbers. Extending from the stern of the boat on the centre line 25 ft. is a well hole through which the dredge pipe is operated. At the bow on the left hand corner a heavy vertical timber or spud slides in girders, to anchor the boat and furnish a point about which to swing the stern over a wide area when dredging.

The two boilers are placed in the hold somewhat forward of the middle, two feet on the left of the centre line of the boat in order to balance the discharge pipe on the right. These boilers are each 16 ft. long, and 6 ft. shell; fire-box 5x5 ft. and 4½ ft. high; three flues, one 15 in. and two 13 in. diameter, each 10½ ft. long; 64 tubes, 3½ in. diameter and 16 ft. long; dome, 4x4 ft., the domes of the two boilers being connected by a drum 20 in. in diameter; and two stacks 28 in. in diameter and 40 ft. high. The boilers are of the return-flue type, containing 1,229 ft. of heating surface each, tested to 150 lbs. and calculated to run at 100 lbs., and made by the American Boiler Works of Chicago.

The Blake Duplex pump is placed on the centre line between the boilers and the well. The steam cylinders are 24x24 in. and water cylinders 12x24 in., working np to 120 strokes per minute. This pump supplies the three inch excavating nozzles, and the water for condensation. Working at an initial steam-pressure of 90 lbs., Mr. Newton calculates they will give a net discharging pressure of at least 270 lbs. or an inital velocity at the nozzle of 200 ft. per second.

The two vacuum cylinders are placed on the stern of the scow, one on each side of the well-hole, 4 ft. 9 in. apart. They are 5 ft. internal diameter, 5½ ft. high inside, each with a capacity of 117 cubic ft. The cylinders are of 6 in. wooden staves with cast-iron heads, with an iron pipe of 400 sq. in. area, elliptical in section, connecting them near the top, over the well-hole. From the upper side of this pipe a vacuum chamber 30 in. in diameter and 9 ft. high projects. To the under side of this is attached a large ball-and-socket or spherical joint to which the suction pipe is connected thus giving it a universal movement. This joint is tapped and connected with the Blake pump, thus giving a water bearing rendering the rotation or inclination at any angle of the suction pipe extremely easy. The suction valves are placed inside the cylinder. They are of the common flap type, of wood seating on a steel ring mounted in a groove and riding a rubber pipe or rope which gives a tight joint and at the same time allows the ring to adjust itself to the valve-face. The valve itself is hinged to top of the cylinder by a stuffing-box hinge provided with an extended handle by which the motion of the valve may be watched, and operated by hand should it become clogged from any cause. The lower head is so shaped as to give a discharge below the level of the staves, the two discharge pipes connecting at a point beyond the well, forming a Y, and valves opening outward, so constructed as to be moved externally are placed just outside the cylinders. These valves give a clear opening of 18 inches, and are hung in a plane slightly inclined to the vertical so as to seat by gravitation in the absence of other forces. The cylinders are filled and discharged alternately, one discharging from the direct pressure of the steam on the contents until they are entirely forced out, the steam in the other being condensed thus producing a vacuum which is constantly maintained during the filling at from 22 in. to 26 in. The distribution of water for condensation is effected by a Barker wheel attached to the top of the cylinder and supplied with water from the Blake pump. This wheel has four arms 22 in. long of 1¼ in. pipe with ⅛ in. slits on the upper side, inclined in such a manner as to rotate the wheel from the reaction of the issuing sheets of water. These sheets strike the under surface of the top cylinder head thus making it serve the purpose of a spring-board. The admission of the steam and condensing water is effected by two rotary balanced valves geared together and operated by a small auxilliary engine, entirely independent of the other machinery, the speed of these engines being regulated at pleasure, as circumstances may warrant. These valves are exactly alike, one being used for water and the other for steam. A brief description of one will be sufficient. It is in reality a double valve, cylindrical, or rather slightly conical in order to seat closely and provide for wear, mounted in a box containing the ports; a diaphragm both in the cylinder and box divides it into two parts; each part has four rectangular ports placed 90° apart all opening into a common chamber about the spindle, which chamber connects with a pipe leading to the vacuum cylinder. The rectangular ports in the opposite ends of the cylinder are so placed that the rotation of the valve successively by eights of the circumference gives a passage alternately to each end of the valve and admits water alternately to each cylinder for condensation. The same duty is performed in reference to the steam admission by the other valve. A slotted disc keyed to the steam-valve shaft and bolted to the face of the gear, allows of any degree of lead or lap. The movement of the valve is practically instantaneous, being effected by an ingenious arrangement of gearing and levers which we have not space to describe. As before stated this movement is ⅛ of a revolution, the time being regulated at pleasure.

As before stated the suction pipe is attached to the water-bearing spherical joint, and extends, when in operation down through the well to the bottom. It can be swung forward and lifted clear of the water in the well if desired. This pipe is of wrought-iron, telescopic, composed of two sections, the upper being 16 ft. long and 21 in. in diameter, the lower 15 ft. long and 23½ in. internal diameter. At the bottom is a cast-iron

WATER WORKS, ANCIENT AND MODERN; DETAILS OF THE VIENNA WATER WORKS.

FIG.1.

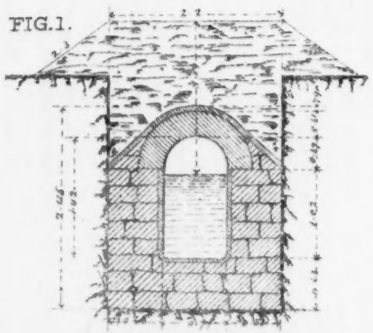


FIG.2.

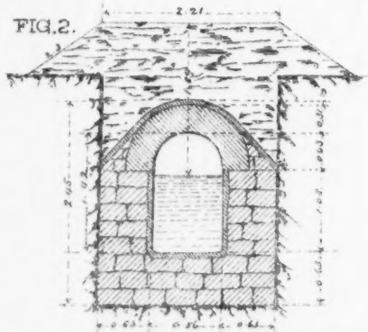


FIG.4.

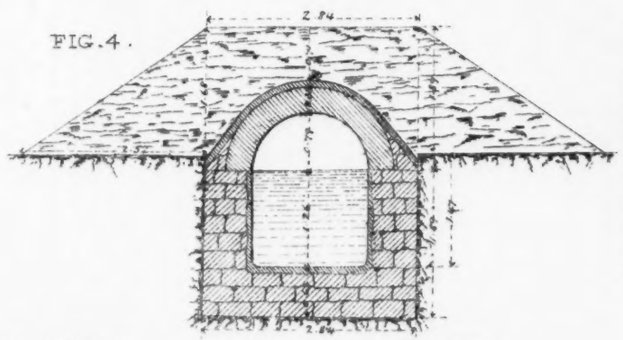


FIG.5.

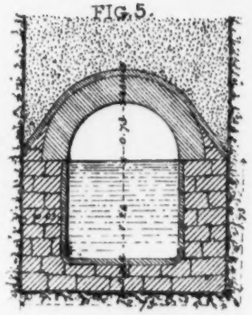


FIG.3.

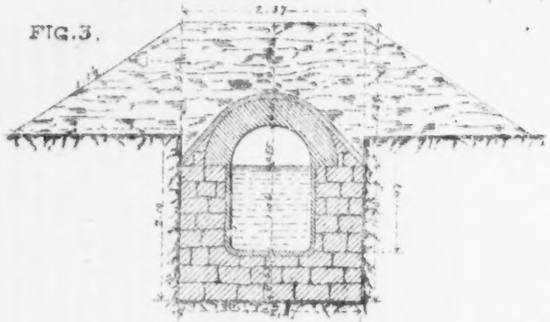


FIG.11.

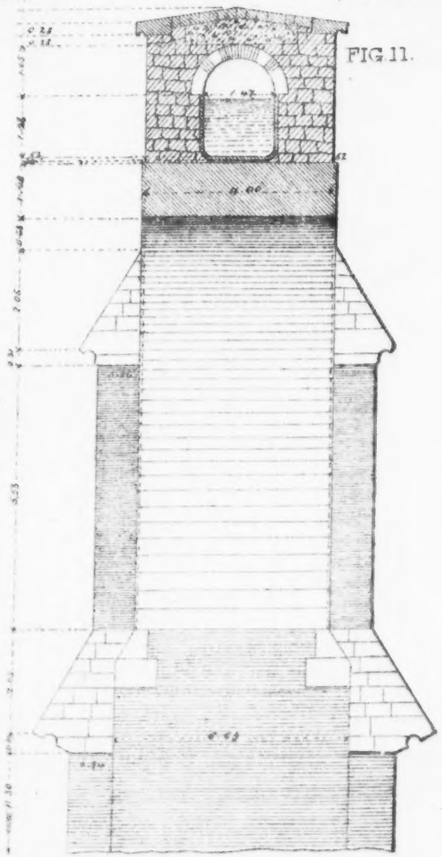


FIG.6.

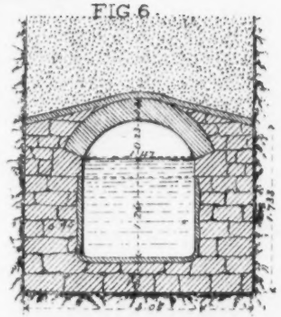


FIG.7.

FIG.8.

FIG.9.

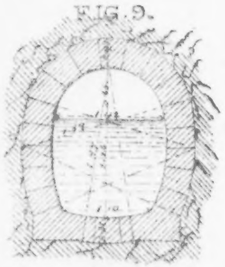


FIG.12.

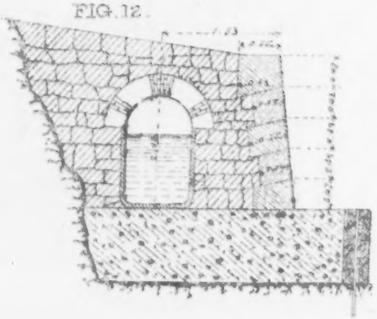
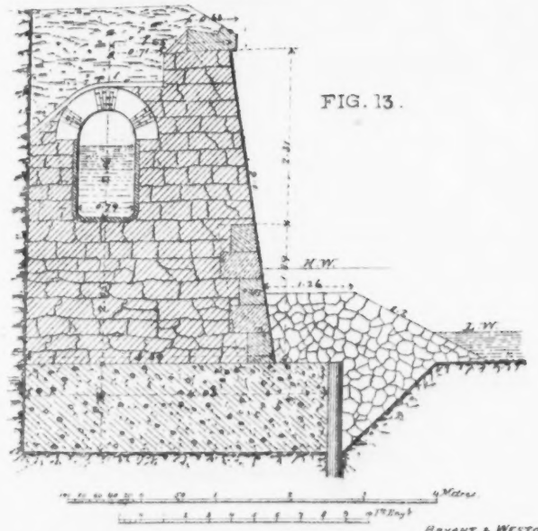


FIG.10.

FIG. 13.



BRYANT & WESTON
Civil Engineers

mouth-piece, opening on one side, to which the jet-pipes are attached, one being led under the bottom and one on either side, the nozzles discharging about 18 in. in front of the mouth-piece. The two side jets are adjustable, being set at any angle according to the nature of the work. Water is conveyed from the force pump by a horizontal 5 in. pipe to near the suction pipe, a heavy rubber hose, 10 or 12 feet long, turning the angle and providing for the descent of the telescopic section, connecting with a vertical 5 in. pipe, attached to the lower section, said pipe joining the three nozzle pipes. The nozzles themselves are each an inch in diameter, shaped to the contracted vein and provided with a thin steel diaphragm inserted through a helical slit of very sharp pitch, thus riffling the issuing stream or giving it a rotary motion which is supposed to increase its efficiency. This stream issues with a velocity of at least 200 ft. per second, which is sufficient to tear clay to fragments and readily disintegrate shale and slate rocks. The disintegrated material is carried in suspension by the stream ascending the suction-pipe to the vacuum cylinders which are alternately filled and discharged. The vacuum cylinders provide for a practically constant or steady flow.

The discharge pipe 18 in. in diameter runs from the Y previously referred to along the right of the centre-line to the bow where a second spherical joint is attached. A second pipe 80 ft. long is attached to the joint supported by iron guys from the top of a 50 ft. mast, set raking so as to bring its top directly over the joint. This pipe is capable of swinging through an arc of 180°. The discharge may take place into dump-scows or upon the land, through pipes or sluices, probably to any desirable distance.

Swinging about the spud in the bow a wide strip may be covered and a considerable distance backward and forward by the swinging of the telescopic section in the well, the rotation of this section, raising, lowering, in fact all the motions of which it is susceptible is effected by means of chains and winches properly disposed. The dredge is capable of working in 23 ft. of water and lifts the material ordinarily to 9 ft. above water. In dredging sand or similar material, a suspension of operations, causes the materials to settle around and in the suction-pipe, making it impossible to again start from absence of water. To provide for such a contingency a pipe turns up just inside the mouth piece which can be opened by a valve, throwing up a stream inside the suction pipe near the side, agitating the sand to such an extent as to provide ready passage for the suspending water.

We think the operation of the dredge can be readily inferred from the foregoing description. The material sent through the dredge of Mr. Green, which was of ¼ the capacity of the one now in operation, and much less powerful, relatively, consisted of from 25 to 40 per cent. of suspended material bulk for bulk. The same dredge in average work has repeatedly given a product of 4 cu. yds. per minute measured in the hopper. Stones as large as could pass the valves readily pass through, one of several which we saw having weighed 39 lbs.

The present dredge is calculated to work 20 cylinders full per minute, or taking the net available capacity at 100 cu. ft. per cylinder, 2,000 cu. ft. of mingled water and material or at the lowest estimate 500 cu. ft. of material, equal to 18.5 cu. yds. per minute, 1,111 cu. yds. per hour or more than 11,000 yds. per day of 10 hours. The superior limit would be nearly 18,000 yds. per day. These figures are fully warranted by the experience with the dredge already constructed.

Running at its maximum a combustion of 1,200 lbs. of coal per hour is anticipated. To operate the dredge requires the labor of four men only. The dredge complete would cost about $12,000 in Chicago, or about $15,000 delivered and set up at Galveston. It will be in operation by Dec., when we expect to give full results which we anticipate will be as gratifying as we have anticipated.

Surveying Legislation.

To the Editor of ENGINEERING NEWS:

Two circulars have been issued by the surveyors of Ford County to the county surveyors of Illinois, suggesting that an effort be made to induce the next Legislature to amend the laws relating to the office of County Surveyor. I have no doubt that all will agree that legislation is needed but I think it would be much better to discuss the matter through the columns of ENGINEERING NEWS than by a private correspondence among county surveyors. I would like to hear your views with regard to what legislation is needed.

To my mind the greatest difficulty to deal with is the lack of competent surveyors, and the disposition among land owners to employ any surveyor that will work cheap. F.

Can any one of our readers inform us why the business of land surveying has always been subject to the paralyzing influence of legislative interference? A physician, having taken his degree may hang out his sign wherever he chooses; he has all mankind for his field, and according to his success as years advance, so do his fees increase, with no one but patients, (or their surviving friends) to question their reasonableness. A young man after a very short period of study in a lawyer's office is admitted to the bar, and according to his talents and energies, advances more or less rapidly to a prominent place in his profession, his fees increasing with his upward progress in a most wonderful ratio. An architect may go where he chooses, and it never occurs to him in choosing a location for an office, to inquire what he may charge for his services or where he will find bondsmen to ensure his clients against loss by his mistakes or carelessness, or ignorance. And so it is with merchants and tradesmen, they have the world for a market and only the questions of supply and demand to study in regard to the prices of their wares.

The doctor's patients may die, or be rendered miserable for the balance of their lives by reason of his ignorance; the lawyer may subject his client to great loss and annoyance by reason of his incapacity or neglect, and the architect may bungle his work from foundation to roof, or by gross ignorance cause his client great additional expense; but in none of these cases does the state legislature interfere to punish or prevent similar recurrences. But when it comes to demonstrating the simplest problem of geometry in the process of land measuring, the ignoramuses who are usually sent to the state capitals to waste the peoples' money and complicate still further the problem of government, imagine they are called upon to exercise their little brains over the proper "regulation of county land surveyors," and the consequence is that a more illiterate, unprogressive, irreclaimable class of men are not to be found in the United States than are engaged in the business of land surveying. There are to our personal knowledge, numbers of active and intelligent men engaged in the profession, who are faithfully and conscientiously performing the laborious and poorly paid duties of their business, and who are desirous of seeing it elevated to its proper rank; with these men we are in hearty sympathy, because we have had a long personal experience in the profession itself, and in addition thereto we have, during the past three years, had especial opportunities for learning more about it than usually comes under the notice of the ordinary observer. But the whole tendency of legislation is to lower the status of the surveyor and the efficiency of his work. The demand for his labor is but a limited one, but his pay is fixed at a minimum rate and he is obliged to go at the call of any client; his office is an elective one and is subject, not merely to political changes, but to local caprice, often of a most trivial character, and which never waits to question the fitness or unfitness of a new candidate for the office; the consequence is, loud-mouthed and scheming ignorance finds more time to push its interests than does honest and conscious worth and industry.

We do not, therefore agree with our correspondent, who we know as a most efficient surveyor, that "legislation is needed." On the contrary we want to see the business of land surveying left free and open to the best men; we do not believe in county surveyor's records, or any of the nonsensical paraphernalia of blanks, etc., that the legislators and the surveyors have encumbered the office with. The records are not in law or otherwise worth anything as records, and the office itself is a stumbling block in the way of reform in the the practice of surveying. When these can be abolished and surveyors, like doctors, lawyers, and architects can hold their practice by force of merit, free from the asinine interference of legislatures, or the restless scheming of little politicians, there may be hope for better days to the profession, and land surveyors may be elevated to something better than the level of a common laborer.

These remarks are offered for what they are worth and we will be pleased to publish a limited amount of discussion that is brought to bear directly on the questions at issue—the office of county surveyor itself—and if it is needed—what legislation will best subserve its efficiency.

Paris Exhibition of 1878.

From the *Moniteur Industrial Belge* and the *Builder* we gather the following particulars concerning the Industrial Exhibition of 1878. The French Senate has lately voted 6,000,000 francs toward the total estimated expenditure of 35,000,000 francs, of which amount 18,000,000 is intended for the buildings in the Champs de Mars, 7,000,000 for those on the Trocadero, 2,000,000 for the widening of the Pont de Jena, and 1,500,000 for the machinery necessary for construction and other purposes.

The area covered will be four times that of the Great Exhibition of 1851, and the plan adopted is that of Messrs. Krantz & du Sommerard, consisting of a vast central building devoted to the exhibition of the fine arts, with great galleries on each side which receive the products of industrial machines of all nations, and having large vestibules at right angles to them containing "objects of magnificence," and full directions concerning the contents and map of the palace. This great building, galleries and vestibules is in the Champs de Mars, the site of the Exposition of 1867, and surrounding will be placed various special buildings by different nations and exhibitors in the midst of tastefully designed parks, which are connected by a new bridge below the Pont de Jena, with the Trocadero, in which are to be erected numerous other buildings, restaurants, cafes, and a great rotunda capable of holding 10,000 persons, also a great iron tower for a permanent monument to be called the Acrobite, no less than 236 metres in height, to serve as an observatory and as a building suitable for experiments on the velocity of light and the fall of bodies. Facilities for getting to and from the Exhibition have been very carefully considered and will be much better than that of 1867.

The regulations drawn up by M. Krantz comprise 40 articles grouped under four sections, namely, 1. General, 14 rules; 2. Special, concerning works of art, 7 rules; 3. Concerning products of industry and agriculture, 7 rules; 4. Administration and police, 11 rules. The Exhibition will open on May 1st and close Oct. 31st, 1878, and will comprise buildings for the most part temporary. It is under the chief direction and responsibility of the minister of agriculture and commerce, but the preparation and execution of all projects relating to construction and management is under the immediate direction of an officer called the General Commissioner, and all communications relative to the Exhibition should be addressed, *Senator, Commissioner General of the Universal Exhibition of 1878, at Paris.* In case the Commissioner feels unwilling to admit an Exhibit, he must consult before action with a special committee for the purpose. Foreign commissions are invited to communicate as soon as possible with the Commissioner General, either personally or through properly appointed delegates, who shall be charged to treat concerning all questions affecting his nation, such as applications and partitions of space, mode of installation, etc., and thus the Commissioner General holds no direct communication with foreign exhibitors; all *exchanges* of space between different nations must be made through him. The exhibits will be classed in nine groups, viz.: 1. Works of Art. 2. Education, Instruction, Material and Processes of the Liberal Arts. 3. Furniture and Accessories. 4. Tissues, Clothing and Accessories. 5. Extractive Industries, Raw Worked Products. 6. Tools and Processes of Mechanical Industries. 7. Alimentary Products. 8. Agriculture and Pisciculture. 9. Horticulture.

Guarantees are given against loss that might be incurred by people copying unpatented inventions, and the rate of storage in bond is reduced fifty per cent. from Jan. 1, 1877 to Jan. 1, 1879, and numerous other rules are laid down, most advantageous to the exhibitors. Water, gas, steam and motive power for machines are given gratuitously. A sum of 15,000,000 francs is appropriated for rewards, to be dispensed by an International jury. C. J. MOORE.

Water Works, Ancient and Modern.*

BY E. H. D'AVIGDOR.

(*Continued from page* 356.)

The whole of these works were carried out in the water, while the mean temperature of the air was about 24 deg., or 8 deg. below freezing; the shed had therefore not only to be very substantially constructed, but constantly warmed by artificial means to prevent the masonry freezing. Finally, in May and June, 1873, the superstructure was completed and the whole work closed. The other tunnels on the line of the aqueduct were far less remarkable. The next in length, that of Voslau (800 yards), was extremely awkward to execute on account of its passing under the most populous and fashionable part of that favorite watering-place, so that it became a matter of great difficulty to find a convenient place for the two shafts it was determined to sink. The transport of the excavated material was rendered very awkward by the confined space available, the extreme steepness of the surface, and the necessity of using the public thoroughfares only, and avoiding the valuable gardens and vineyards which cover the whole hillside. This tunnel, which is lined with ashlar throughout about half its length, was executed by Piedmontese miners, first with gunpowder and afterwards also with dynamite.

It would be tedious to describe the numerous minor difficulties which were met with at most of the nineteen other tunnels. Beyond those inseparable from the nature of the soil, they were all attributable to the small space available at the mouths of the tunnels, the very limited ground handed over to the contractor to work on, and the atrocious state of the devious country roads on which all the materials, both from the excavation and for the masonry, had to be led. The economy of the municipality in the purchase or hiring of land for storing materials or running to spoil, approached parsimony, and could hardly pay in the long run, but of course the absurd prices demanded by the numerous small landed proprietors for the most worthless plots, sufficiently explains a policy which might otherwise appear short-sighted.

In the course of this paper I have frequently used the word *aqueduct*, and have employed it in two senses, namely, either as an expression for the canal or conduit itself, or as signifying the bridge or arches by which the canal is carried over valleys and rivers. The context generally shows clearly what sense should be given to the word, and the confusion arises from there being no expression in English corresponding to the German one of "Bogenstellung," or "set of arches," which applies equally to a road, railway, or aqueduct. I must now say a few words about the aqueducts of the Vienna Water Works in the narrower sense of the word, that is on the means adopted for crossing the valleys met with on the line.

The principal ones are those of the Triesting and Kaltengang at the lower extremity of the "Stonefield," already mentioned; the Schwechat stream passing through Baden, the Bruhl at Modling, the Liesing stream, and thd Mauer stream close to Vienna. While the bed of the first-mentioned resembles the torrents on the Italian Riviera, which the old diligences used formerly to drive through, jolting their unfortunate passengers over stones as big as a man's head, and frequently upsetting—wide, generally dry, and with only here and there a little water meandering across the sandy waste, with no decided course, and all the more dangerous for that very reason, *all* the latter flow down very clearly defined beds in valleys bordered by hills, whose height attains (and in the Bruhl exceeds) 1000 ft. I have already mentioned that no inverted siphons whatever are employed, and that from Kaiserbrunn to Rosenhugel the water falls by a continual natural gradient. To carry out this principle in its integrity, it became necessary to construct a number of flat arches to cross the wide, shallow streams of the Steinfeld. The most troublesome of these bridges was that of the Kaltengang, which, like all the others, is generally a harmless stream enough, but occasionally after heavy rains, or when the ice breaks up, brings down enormous masses of water which find their way to the Danube in a very short time. The principal opening is of 36 ft. span (Austrian measure, equal to about 37 ft. 8 in. English) and has three side openings of 24 ft. The principal span consists of a separate arch with a rise of only 3 ft., or rather less than one-seventh the span, while the side openings have a rise of 3 ft., or only one-eighth. In such a situation, where the level of the invert of the conduit cannot be raised, and its height above the bed of the stream is very small, while the span must not be diminished in order to give the occasional violent floods sufficient room, the hydraulic engineer is at a great disadvantage in comparison to the constructor of railways. Such a span would present no difficulty to a railway engineer; he would simply erect an ordinary girder bridge. But it appeared impossible to construct a girder bridge for the conduit over the Kaltengang, for it was necessary to keep at least 3 ft. of masonry between the water and the atmosphere, and also to have a continuous, impervious, and smooth lining for the inside. Considering the enormous change in the length of the iron, due to a variation of temperature of 100 deg. Fahr., a fixed joint was an impossibility, and a movable one appeared equally difficult to arrange. Flat arches were therefore constructed of ashlar masonry. The voussoirs were all roughly dressed to template in the quarries, and finished off on the work; in the principal span they are 4 ft. thick at the springing, tapering to 3 ft. at the crown. In order to carry the tremendous thrust of these heavy segmental arches, the piers were constructed of ashlar 15 ft. thick, and these excessive dimensions have certainly prevented the slightest crack or settlement in the work. The most tedious operation was the centering of the large span, on account of the low headway, the bad ground, and the immense weight of the voussoirs. It required a forest of timber, and cost within a few pounds of the same price as the whole of the masonry itself.

The Leobersdorf aqueduct across the Triesting is 820 feet long, and consists of 20 segmental arches of 30 feet. span and 7½ feet rise. The piers are all built on piles, as the whole bed of the Triesting consists of sand and alluvial deposits, which change their position during every flood. The principal openings for the stream in its normal course differ from the rest in being constructed of ashlar, while the others are brick; they are 6 fee. wider, and the only thing remarkable about them is that the segmental arch is carried right through the abutment on each side, so as to transfer the thrust directly to the ground itself, the central pier being in equilibrium between the two.

(*To be continued.*)

* A course of papers delivered at the Austrian Institution of Engineers and Architects, December, 1875, and January, 1876.

American Institute of Mining Engineers.

At the October meeting of the Institute recently held in Philadelphia the following resolution, offered by A. L. Holley, was unanimously adopted:

Whereas, The novel, wise and useful design of the Centennial Commission of this Institute, and its most judicious execution—in opening rooms in the city of Philadelphia, in furnishing them with a large and instructive collection of maps and publications; in organizing weekly conversaziones; in extending courtesies to all engineers; in furnishing information concerning localities, routes, and works, to foreign guests; in bringing together inquirers from all parts of the world; and the workers, managers, and owners of American machinery, and engineering and metallurgical works—have been so conspicuously useful and agreeable to our foreign professional brethren especially, as to call forth from them a universal expression of gratitude, and a general determination to follow the example of the Commission on similar occasions, in their own countries;

And whereas, The co-operation and courtesy, during the period of the Centennial Exhibition, of the Centennial Commission of the American Society of Civil Engineers, and of the members of that Society at large, with our own Centennial Commission, and with the members of this Institute at large, has not only facilitated the accomplishment of the results referred to, but has led to a wide acquaintance, and promoted the growth of a kindly feeling between the members of the two societies; therefore,

Resolved, That the sincere thanks and hearty congratulations of the Institute are tendered to its Centennial Commission, for its valuable services to the guests of the Institute, and to the Institute itself, in promoting its objects and extending its influence;

Resolved, That the thanks of the Institute are especially due to the Secretary of the Centennial Commission, MR. WM. G. NEILSON, for his most thoughtful, courteous, and laborious services to its guests and members;

Resolved, That the Institute tenders its congratulations to the Centennial Commission of the American Society of Civil Engineers, not only with regard to the success of the work in which the two societies haae co-operated, but in the belief that the acquaintance and good feeling developed during their agreeable labors, will permanently establish such harmonious relations, and, from time to time, lead to such further co-operation as will, in a still greater degree, benefit the two societies and the profession at large.

The following persons having been duly proposed and endorsed by the Council, were then elected members, or associates, of the Institute;

Honorary Member.—Richard Akerman, Stockholm, Sweden.

Members.—John Bogart, Civil Engineer, American Society of Civil Engineers, 4 East 23d St., New York City; Fred. Everett Bruen, E. M., Essex Public Road Board, Newark, N. J.; Robert Bunsen, M. E., Assayer and Chemist, Boyd's Smelting Works, Boulder, Col.; W. E. C. Eustis, Mining Engineer, Readville, Mass.; Fred. M. Gordon, Mechanical Engineer, Ironton, Lawrence County, Ohio; George N. Grey, Ironmaster, Huntington, Cabell County, W. Va.; William G. Hamilton, Civil and Metallurgical Engineer, 30 Broadway, New York City.; James Armory Heorick, Superintendent Steel Department, Nashua, N. H.; R. F. Hoke, Raleigh. N. C.; Joseph L. Hunter, Mechanical Engineer, 426 Walnut St., Philadelphia; William Kent, M. E. Stevens Institute, Hoboken, N. J.; Gabriel Leverich, Secretary American Society Civil Engineers, 4 East 23d St., New York City; Oliver Matthews, B. M. E., Bessemer Steel W'ks, Bridgeport, Chicago, Ill.; F. H. Oliphant, Jr., Superintendent Mercer Mining and Manufacturing Company, Pardoe, Mercer County, Pa.; John N. Pott, Assistant Mining Engineer, Tremont, Schuylkill Co., Pa.; F. B. F. Rhodes, Mining Engineer, Drifton, Jeddo, Luzerne County, Pa.; Charles M. Ryder, Metallurgical Engineer, Otis Iron and Steel Works, Cleveland, Ohio; General Samuel Thomas, General Manager Columbus Rolling Mill Company, Columbus, Ohio; John Fraser Torrance, Mining Engineer, Montreal, Canada; Edwin A. Wetmore, E. M., Marquette, Michigan; John T. Wickes, Civil and Mining Engineer, Lowmoor Mines, Selma, Allegheny County, Va.; Ed. H. Williams, Jr., Mining Engineer, Drifton, Jeddo, Luzerne County, Pa.; John I. Williams, General Superintendent Graff, Bennett and Co.'s Works, Pittsburg, Pa.; Dr. Otto Wuth, Chemist, Pittsburg Pa.

Associates—Benjamen F. Chynoweth, Rockland, Mich.; James B. Mackintosh, 55 Garden St., Hoboken, N. J.; Frederick N. Owen, Nyack, Rockland County, N. Y.; Nelson W. Perry, School of Mines, New York City; Holmes E. Sadler, New Haven, Conn.; Milton S. Thompson, Islip, L. I., New York; F. Von Cabeen, 201 Walnut St., Philadelphia.

Foreign Members.—Lucion Arbel, Senateur, Rive de Gier, Loire, France; T. Fayen, Liege, Belgium; Adolphe Henry, Rive de Gier, Loire, France; Prof. Hans Hofer, Klagenfust, Austria; Prof. Nicholas Jossa, St. Petersburg, Russia; Ferdinand Valton, Rue Lepeletier, 20, Paris, France.

Publications Received.

HANDBOOK OF MODERN STEAM FIRE-ENGINES, including the Running, Care, and Management of Steam Fire-Engines and Fire-Pumps—with Illustrations. By Stephen Roper, Engineer. Price $3.50. Chicago: Jansen, McClurg & Co.

A PRACTICAL TREATISE ON ROADS, STREETS AND PAVEMENTS. By Q. A. Gillmore, A. M., Lieut. Col. U. S. Corps of Engineers. Price $2.00. Chicago: Jansen, McClurg & Co.

PRINCIPLES OF APPROXIMATE COMPUTATIONS. By Joseph J. Skinner, C. E. Instructor in Mathematics in the Sheffiefd Scientific School of Yale College. Chicago: Jansen, McClurg & Co.

THE FATIGUE OF METALS UNDER REPEATED STRAINS, with various Tables of Results of Experiments. From the German of Ludwig Spangenburg, with a Preface by S. H. Shreve, A. M. Price 50 cts. Chicago: Jansen, McClurg & Co.

From the Institution of Civil Engineers:

The Resistance of Boiler Flues to Collapse. By Prof. William Cawthorne Unwin. M. Inst. C. E.

Abstract of Foreign Transactions and Periodicals.

Railway Rolling Stock; Comprising the Following: I. On the Construction of Railway Wagons, with Special Reference to Economy in Dead Weight. By Walter Raleigh Brown. II. Railway Rolling Stock Capacity, in Relation to the Dead Weight of Vehicles. III. Discussion upon the Foregoing Papers.

Reading Cases.

In the first year of our publication we had calls from nearly all of our subscribers for "reading cases" or "binders" which we supplied; the double rates of postage in the following season completely cut off the trade in them, but we can now again send them by mail, postpaid, at the manufacturer's retail rates. The advertisement will be found in another column, and we can recommend these cases to all who desire to preserve clean and complete files of ENGINEERING NEWS or of any other publication.

IMPERIAL TECHNICAL SCHOOL OF MOSCOW.

In our paper of last week we were led to speak of the Russian technical school, as an example of what can be done in systematic practical training, as proved by the exhibit at Philadelphia, and we proposed to give an abstract of the course of instruction in this school, as explained by an official pamphlet which has come to our hands. The school consists of two divisions, general and special, each of which has a three-years course, and the latter division embraces instruction in mechanical Construction, Mechanical Engineering and Technological Engineering. In the general division the pupils are taught, free-hand and linear drawing, descriptive geometry, general physics, the natural sciences, chemistry, geodesy, mathematics including the calculus, general mechanics and languages. In the special department they study organic and analytical chemistry, metallurgy, practical physics, mechanical and chemical technology, technics of wood and metals, analytical mechanics, construction of machines, practical mechanics, railway construction, engineering and constructive art, designing and estimating machines, works and mills, industrial statistics and book-keeping. A preparatory department has also been added.

Each one of these topics or sciences is taught fully or in a condensed form, according as it is considered a fundamental or only a collateral subject of the particular branch. All of the students are busied during a stated time in practical work in the laboratories and mechanical workshops. The school possesses a library of more than six thousand volumes or specialties, physical apparatus, mechanical models, a cabinet of natural history, two chemical laboratories, extensive mechanical works with foundry and blacksmith shops, and also school workshops.

Young men studying in technological engineering are admitted to the laboratories, but, for the practical education of the mechanical engineers and mechanical constructors, the school possesses large mechanical works with hired workmen, taking orders from private individuals, in a business way, for the construction of steam engines, working engines, pumps, agricultural machinery, etc. These orders amount to from $35,000 to $45,000 annually.

The works consist of—joiners shop, machine shop, erecting shop, painting shop, blacksmith's shop with steam hammer and fan blast, iron foundry and brass foundry, besides draughting room and counting-house attached. A steam-engine of thirty horse-power and another of ten horse-power furnish the motive force.

These works, being within the walls of the institution itself, and carefully superintended, would be of important assistance in the instruction of the pupils, even if the student took no active part in their practical working. But, that the young men may derive the greatest possible advantage from such auxiliaries, the school also possesses workshops, intended solely for the use of the pupils:—joiners shop, pattern shop, metal working shop, fitting shop, smithy and moulding shop; each one under the charge of a skilled workman. After an obligatory course in these shops, embracing all kinds of mechanical work, the scholars are admitted to the large works above mentioned.

By this means the school council have secured the systematic teaching of the elementary processes and manipulations, with convenient supervision, in the least possible time, all the processes being carried through by a regular gradation and method, as that the student surmounts, little by little, the difficulties which lie in his way. That a necessity for such a method exists, more particularly for technical educational establishments, admits of not the slightest doubt, and the filling of this want promises evident advantages, not only in the matter of a scientific technical education, but also for the practical instruction of work people, and, consequently, for the perfection of mechanical hand labor itself, which, from the introduction of specially adapted machinery, is, year by year, perceptibly deteriorating.

For teaching any mechanical work whatever, the course of instruction is naturally divided into three parts: first, acquaintance with all of the instruments employed; second, performance of stated and graded tasks in simple processes; and third, the construction of parts of machines or of other work, in which the previous operations shall be successively performed. For instruction in the first part, this school has prepared models of cutting instruments on a very enlarged scale, so that it is possible for the student to see clearly the minutest details of their construction. The direction of the cutting edges, the proper bevels, the shape of the surfaces which from the working part of the instrument can thus be studied easily and clearly:—thus a smooth file, enlarged to twenty-four times the natural size, shows the shape of the teeth and the surrounding surfaces plainly. The same is true of drills and screw cutting tools. All other tools are illustrated by full-sized samples.

In the second section the pupils practice simple operations, for example;—in carpentry, sawing to a line, straight or curved, planing to a definite shape, making joints of different kinds;—in turning in wood, making cylinder, cone, channelling, irregular outlines, cutting screws, etc;—in turning metals, turning a cylinder, bolt with head, pulleys, cylinder bored out inside, cone, bevel wheels, etc.;—in forging, making square from round iron, or the reverse, square nuts, hexagonal nuts, bolts with heads, ditto with eyes, welding of round iron, steeling of hammer-face, etc.;—in filing, clearing casting, chipping with cold chisel, filing to a line, filing a plane surface, filing of different solid forms, drilling of holes, filing keyway, etc.; and finally he learns how to line out work. In the third stage, all these processes are applied to model making, moulding, forging, turning up, fitting and finishing parts of machines, etc. Samples of the work done in the school workshops, and how well it has been done, could be seen at Philadelphia. After these tasks have been performed, we can readily see that the scholar is fitted to the best advantage to go into the large machine works connected with the school and to aid in the designing and construction of complete machines. His theoretical and practical study has kept pace together and his hand is prepared to execute what his brain will design, while he has become acquainted with the present capabilities of our tools and methods, and the most advantageous way of going to work.

Some remarks in the pamphlet from which the above abstract is made, and which we had not before seen, are so apropos to our subject of last week that we will close by extracting them.

"Up to the present time throughout the world, the workmen at industrial works and mills are usually self-taught. Any one who has himself been employed at a works, and is familiar with the daily life of the workmen in the different countries, must have perceived that the acquirement of knowledge and skill in any trade is to him a process much similar to the following:—A boy of thirteen or fourteen years of age, having entered a mechanical works to learn his trade, is put, during the first few years, to work of an entirely unproductive kind and which has not the slightest relation to technics. He is made to carry water, sweep the workshops, crush emery, grind colors, etc. Only after the lapse of a few years, and probably, thanks to accidental circumstances a chisel or a file is put into the hands of the youth, and and he is set to perform the rudest and simplest kind of work.

"Then also, if he happens to have neither father nor brother among the workmen around him, he begins learning his trade without a guiding hand, and thus commences acquiring practical knowledge and skill in his trade by observing those about him in the workshop, and by his own thought and calculation, and impelled by the sole desire of attaining, in as short a space of time as possible, the position of a paid hand in the works. There can be no doubt that, under such circumstances, the acquirement of skill by the new generation of workmen takes place in an extremely irrational manner and without any system; the amount of knowledge obtained depends upon accident, and the time thus employed is of disproportionate length."

"This order of things has the deplorable result, that, notwithstanding the long continued stay of the young workmen at mechanical works, which is sometimes prolonged through the major part of the years of their manhood, well-taught and skilled fitters are almost everywhere rarely to be met with."

We publish this week in our advertising columns a list of works relating to Hydraulics and Sanitary Engineering, any of which will be sent post-paid on receipt of price, to any part of the country.

CHEAP SCIENTIFIC BOOKS.

A correspondent objects to our publication of Latham's "Sanitary Engineering," and says:

"I feel the value of your paper much lessened by this policy of reprinting works that are of easy access to most engineers. The current proceedings of scientific societies, and descriptions of works in actual progress are matters of general interest and at the same time are not easily obtained by the many; these in my opinion, would be better and more acceptable matter to the mass of your subscribers, than these reprints of works in full circulation."

After giving the matter a great deal of consideration we decided to republish Latham's book for three reasons: 1st, because it is the most complete treatise extant on a very important subject; 2d, because it *was not* of "easy access to most engineers" by reason of its limited edition and great expense, and therefore that we would be conserving the interests of the profession by its republication in a cheap form, and 3d, because we thought it *would pay*.

We need not say anything as regards the merit of Mr. Latham's work, but will leave it to be judged by our readers as we progress in its publication. We are not aware of any other treatise on the subject that enters into the details of the construction of sewers as this does. We may state also that our design in publishing it is to make it a basis for a series of articles, and for considerable discussion, on the subject of sewerage, so that the City Engineers of America may be able to have in one volume the latest and best ideas of both English and American practice, and so be able during the winter months coming on to get such assistance in forming plans of sewerage as may be obtained therefrom.

Last year we imported several copies, and by reason of advertising it in our paper, had created quite a demand therefor; we let our own copy go to accommodate a friend who wanted it at once, and we had twelve orders for it on hand at one time, from engineers in different sections of the country, but to whom we were obliged to return their money on account of the edition being sold out. The American agent of the publishers in reply to our last orders for the book intimated that the time for issuing a second edition was very indefinite, and so scarce had the book become that we paid Van-Nostrand fifteen dollars for the last copy he had, and, by mere accident succeeded in getting one for ourself only a few weeks ago. Now while the principal engineers of the country may have the money to buy all the expensive books that are offered, yet, of our own knowledge, we are certain that to the great mass of the profession, those books, that form in large measure the fountains from which the best and latest information on subjects that all are interested in, are denied; we cannot but think, therefore, that when the matter is fully examined by our correspondent he will, with the rest of our readers, concede that we are performing a most valuable service for the profession in giving them at so cheap a rate a book of rare merit, and withal so expensive that it is practically of access only to a favored few.

In regard to publishing the current proceedings of scientific writers, and descriptions of works in actual progress, we have done so to as large an extent as we could get such information, without going to an outlay of money that was unwarranted by the patronage of the civil engineering profession; the engineers who have charge of the great works of the country profess to have *no time* to encourage an American journal devoted to the interests of the profession by even subscribing for it, let alone contributing to its columns the accounts of the works under their charge, with drawings to illustrate the same; the papers read before the societies are mostly quite voluminous, and to be of real use require the reproduction of numerous very expensive plates, which at the exceedingly low price of American technical journals as compared with foreign ones is out of the question. The price of the cheapest English engineering journals is over ten dollars, and they are the favorites of advertisers;—*Engineering* never having less than 32 pages of first class advertisements, mostly of machinery manufacturers,—if even the American patronage that is extended to these journals were bestowed at home, the engineers of America might have as valuable and interesting a professional journal as any country on the globe can boast; we have set out to produce just such a publication but can go only just so fast as our patronage will warrant. We have now on our list a

large number of the very foremost engineers of the country and the number is augmenting daily; if we can do anything to get them to display their interest in our enterprise, even though it may be adverse criticism, we will consider that we are making satisfactory progress.

We think our scheme *will pay*, and therein lies a great portion of its excellence to our mercenary mind. In fact, we know it will pay, now that we have tasted the first fruits of our venture, and we think all our subscribers will be glad also to know of that fact as well as we. If anything had led us to doubt the propriety of our policy in reproducing such a work as Latham's, the flood of subscribers that has poured in upon us during the past two weeks would have completely dispelled any such sentiment; from every part of the country the names are coming, and the subject is one of such importance to all classes of people, who value their own health and the health of their fellowmen, that our effort to popularize it and give it in a cheap form is being appreciated by large numbers who never expect to construct a sewer or lay a drain. We expect to secure the subscription of very nearly every city engineer in this country, and already the contractors and trades-people interested in the construction of sewers are finding out that the "best thing yet" is now to be had for a trifle. The back numbers of our paper are entirely exhausted, but the sheets of "Sanitary Engineering" are stereotyped and can always be had by new subscribers to ENGINEERING NEWS. We hope to see the interest in our more prominent enterprise greatly extended, but at the same time we propose to bestow extra efforts in continuing to place before our readers subjects acceptable to them all.

ON account of setting the Tables referred to in last number, "Sanitary Engineering" is omitted this week.

AS will be seen, the correspondence in relation to "Sanitary Engineering" is opened this week, and we hope to see a genuine interest in the subject manifested at once by engineers and architects. This correspondence will be published from week to week, and at the close of our re-publication it will be carefully edited and reprinted as an American appendix to Latham's book.

THE attention of persons wanting drawings for any purpose is directed to the plate which accompanies this number of our paper. This, and the others that have appeared in ENGINEERING NEWS since September have been printed directly from the transfer to the stone, of Mr. Weston's drawing, and we think they will bear comparison with the originals. The plates that are to illustrate "Sanitary Engineering" will be re-produced in the same way, and we believe that by this method parties can obtain through Messrs. Bryant and Weston lithographed drawings at prices that will surprise themby their cheapness. This plate and the one of last week were printed at the *same time*, and the paper afterwards cut; by thus covering a stone with several "jobs" at once, the cost of printing is largely reduced for each, and as Messrs. Bryant & Weston are interested only in being paid for the *drawing*, so it will be seen that the advantages which they offer are very considerable. As an instance of the difference in prices we may state that an estimate given us by a Boston firm on our plate of Boston Sewerage, at $250. we completed ourselves for just *twenty-five* dollars and one day's drawing, and wewill be glad to turn out just as good work as the Boston map in unlimited quantities at the latter rates, or say fifty dollars, including drawing, paper, and printing. As a very important part of an engineer's business is to get the greatest amount of good work for the least amount of money, so it may be worth while to get an estimate on the kind of work here offered, whenever it is wanted.

CIVIL ENGINEERS' CLUB OF THE NORTH-WEST.

The regular meeting of the Club was held in the Tremont House Nov. 14th, President Chesbrough in the chair.

The minutes of the October meeting were read and approved. Mr. E. H. Mott, Assistant Engineer on the Chicago & Alton R. R., was proposed for membership. Upon ballot the following gentlemen, proposed at the October meeting, were elected members: C. H. Hudson, Division Superintendent C. B. & Q. R. R.; W. D. Clark, City Engineer, Springfield, Ill.; C. A. Clinton, Assistant Engineer Chicago & Alton R. R.; and Mr. C. Nutt. The Secretary reported donations from Chas. E. Fowler, City Surveyor, a copy of the "City Year Book," for 1875, of the city of New Haven, Conn., and from Gen. A. A. Humphreys, Chief of Eng. U. S. A., a copy of Vol. V of Report on Geographical Surveys west of 100th Meridian.

The paper for the evening, "A New Method of Traction on Canals," was read by Gen. W. Sooy Smith. A model of the proposed "Tractor" was exhibited in connection with the paper.

The President announced the death of one of the oldest members of the Club, Mr. William Bryson, giving a short account of his professional work, and eulogizing his personal character.

A resolution was passed that a committee of three be appointed by the President to prepare a series of resolutions upon the death of Mr. Bryson, The Chair appointed Messrs. Morehouse, Potts and Williams as such committee, after which the meeting adjourned.

L. P. MOREHOUSE, *Secretary*.

American Institute of Mining Engineers.

OCTOBER SESSION.

(Special Correspondence of Engineering News.)

This association recently met in Philadelphia for their autumnal session on the evenings of the 24th, 25th and 26th ult., the meetings being held in the hall of the Franklin Institute. The first paper read was by Mr. Price Wetherell of Tremont, Pa., entitled "An Outline of Anthracite Coal Mining in Pennsylvania," of which the following is an abstract:

The seams are from 3½ to 100 feet thick, containing coal, slate and "dirt," the latter composed in part of iron pyrites. Upper strata are sandstone and the floors slate. The general plan of working is to reach a point in the seam by permanent outlet; the amount of the seam worked by one set of operations is called a "lift," and a width of 100 yards on the *pitch* and ¼ miles on the *strike* of the seam is considered the limit of profitable mining. The plans of working are four, viz., 1. The Drift, which is driven in the direction of the *strike*, the cheapest method as no pumping or hoisting machinery is required; 2. the Tunnel, which is driven at right angles to the seam; 3. the Slope, and 4, the Shaft with galleries driven therefrom at different levels according to the lay of the coal.

The coal wagons used have from 75 to 100 cubic feet capacity; gauges are of two kinds, broad from 42" to 44" and narrow from 30" to 36"; locomotives are only used when firedamp is entirely absent. (Reference was then made to drawings showing systems of working with "gangways," "breasts and pillars" and "shutes" which connect each breast with the gangway). Breasts are 8 yards long by 6 to 12 yards wide; 10 to 15 yards is the size of the Pillars where the top is strong and 5 to 7 yards where it is weak. A breast is kept open for mining constantly; a gangway is only kept open so long as coal can be mined above it. Where the *pitch* of the seam exceeds 40° the breast is worked "by the run" Ventilation is effected by manways which are two holes or channels temporarily boarded off, one at each side of the breast and never more than 6 feet from its face. (The construction of the manways and their method of acting as ventilators was then illustrated by diagrams). Coal is generally drawn first from the main breasts instead of from the manways, in order that the ventilation may not be interfered with. In working "by the run" everything must be taken out with the breast of coal including unprofitable impurities; this fact occasionally renders it impossible to use that plan, and then the mode used is to work "on batteries." This latter plan is used when the seam is 12 feet or less in thickness; breasts worked "on batteries" are worked by wagons, the impurities, called "gob" are collected together and used for filling up old workings. When the pitch of the seam is from 12° to 28° the shutes are lined with sheet-iron to render possible sliding down blocks of coal to the wagons in the gangways; above 20° steepness the coal slides down of itself, from 12° to 20° pitch the coal must be pushed by hand; from 6° to 12° pitch the breast is worked by "buggies," below 6° the wagons are run up direct to the face of the breast. As in this method wagons take in timber to the breasts and return taking out the coal, "runs" can profitably be made of greater length than when working on other plans at greater pitches. "Panel working" is not yet adopted in anthracite mining except experimentally. (Various systems of "pillars and bord" working were then described with the relative value and economy of each, and also the plan of working with countershutes—illustrated fully by diagrams). Worked out breasts of a steep pitch are frequently converted into inclined planes. The direction of the "creep" in anthracite does not, as in bituminous coal mining, influence the direction in which breasts are driven. Tunnels are generally made 7 feet high by 10 feet wide. Air-compressing machinery for tunnel-driving is used very sparingly in the anthracite district.

The discussion which followed was participated in by Eckley B. Coxe, R. P. Rothwell. Oswald J. Heinrich and the author of the paper, and elicited the following facts: The miners are paid by the wagon load, not by the yard; the proportion borne by the coal gained to the waste in different systems of mining is from 28 to 30 per cent., this being the average yield of coal veins in the anthracite region swith pitches of 30° to 50°. Mr. Heinrich spoke at length, advocating a much more careful system of mining anthracite, speaking strongly in favor of the system he used in bituminous mining.

The paper was an able and concise summary of present practice in anthracite mining, and was listened to with great interest by an audience of over one hundred members.

The second meeting was held on the succeeding evening, Oct. 25th, and opened with the preliminary Report of the International Committee appointed at the last session of the Institute to consider the "Nomenclature for Malleable Products of Iron," read by A. L. Holley.

The conclusions arrived at and recommended for international adoption were:

First, that all malleable compounds of iron aggregated from any forms not in a fluid state, which resemble what is now called *wrought iron*, shall be called *weld iron*;

Second, Compounds which will harden or temper including what is now called *puddled steel*, shall be called *weld steel*.

Third, All compounds cast from the fluid state into *malleable iron*, shall be called *Ingot iron*.

Fourth, That all such compounds which will *harden* shall be called *Ingot steel*. The members of the committee are Messrs. A. L. Holley and T. E. Egleston, American, Dr. I. Lowthain Bell, British, Dr. Akerman, Swedish, Drs. Wedding and Gruner, German, and Dr. Turner, Austrian.

This report was followed by a paper on the "Nomenclature of Steel and Iron," by Mr. Wm. Metcalf, steel manufacturer of Pittsburgh, which was throughout a very strong argument from the conservative point of view, opposing any change of present nomenclature,—"let well alone." The author first gave a history of the origin of the terms wrought and cast iron, and wrought and cast steel; the last being subdivided into Crucible, Bessemer, and Siemens-Martin Steels. The terms blister, shear, and German steels have been almost abandoned in Europe and partly so in America; the term *steel* is generally used in Europe for all grades of carbonized iron. Cast iron and cast steel were to be considered with reference to the proportions of carbon they contained and was most conveniently accomplished by the aid of a diagram, which may be drawn as follows: Let *a d b* be a right-angled triangle in which ordinates from *a d* the base, to *a b* the hypothenuse represents amounts of carbon in any alloy of iron and carbon, *a* being *nil* that is the point of pure malleable iron; *b d* the maximum percentage of carbon in cast iron, and *c* some undetermined point between *a* and *b* at which cast-iron merges into steel; then *b c* will represent a scale of percentages of carbon in cast-iron and *a c* those in steel. The gradual changes from the highest cast-iron to the lowest steel were then traced along the scale. The specific gravity varies from 7.14 to 7.55, increasing from *b* to *a*; the point of extreme hardness is about *c*, of softness at *a*. The tensile strength, compression and resilience were then traced throughout the scale; next, tempering was considered and the hardening temperature of white cast-iron shown to be that of fusion. The structure of a *chill*, proves that iron rather than *carbon* is the metal chiefly affected thereby. Changes in the quality of steel are due to change in the

structure of the carbon, rather than to varying proportions of iron and carbon mixtures. The line *a b* should either be called *iron* altogether, or *steel* altogether. The qualities of various iron and carbon combinations of different proportions were then examined (1) In their Continuity, (2) Similarity, and (3) Difference. The author then used some very strong arguments against changing present nomenclature, and closed with recommending the continuance of the present terms wrought-iron, cast-iron, and cast-steel.

This paper, taken with the preceding report which Prof. Raymond denounced as a compromise, led naturally to a very lively discussion, the principle features of which was a long duet by Messrs. Raymond and Holley, aided by Mr. H. M. Howe, accompanied *ad lib.* by Prof. T. E. Egleston, relieved by a slight intermission during which Prof. Wm. P. Blake mildly recommended to notice the admirable commercial classification of the Creusot works. So great was the interest manifested that the discussion was finally adjourned to be again taken up in the Session next February.

The next paper read was one on "Coal Statistics," by Mr. R. P. Rothwell. He stated that the first anthracite mined in this country was in 1765 in the Wyoming region, and statistics are fairly complete and reliable from the first commencement up to the present time. This is not the case with bituminous coal, for though it was mined long before anthracite, yet no statistics appeared until the Census Reports of 1869-70, where out of a total of 29,342,580 tons (gross), there was 13,973,460 tons anthracite, the remaining 15,369,120 tons being bituminous and lignites, etc. The total production for 1874 was 47,813,925 tons of which 21,684,386 tons were anthracite, and the remainder 26,129,539 tons bituminous. Last year's (1875) production of all kinds was 47,513,235 tons including anthracite 20,654,509 tons, bituminous 26,110,926 tons, and lignites 747,800 tons, and of this total Pennsylvania mined 65.54 per cent., anthracite 43.44 per cent., and bituminous 22.10 per cent.; the other States mined the following amounts: Ohio 9.15 per cent of the whole, Illinois 7.37 per cent., Maryland 4.94 per cent., Iowa 3.16 per cent., West Virginia 2.32 per cent., Indiana 1.69 per cent., Missouri 1.58 per cent., and all the other States less than one per cent. each.

A short discussion followed in which Professors Raymond, Blake, and T. Sterry Hunt took part. Some objection was raised to the term *lignites* as used by Mr. Rothwell to include all brown or other than bituminous or anthracite coal, and Prof. Blake proposed as a substitute "post-carboniferous," which was agreed to and accepted by Mr. Rothwell.

The third meeting of the Session was held on the following day (Oct. 26th) at 10 a. m., the first paper read being on "An Apparatus for the Volumetric determination of Ammonia and Sulphur on Coal Gas," by Messrs. B. Silliman and another; this was followed by a short discussion neither of which would interest the readers of the NEWS.

C. J. MOORE.

Notes and Memoranda.

SELECTIONS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS. FROM CORRESPONDENCE.

American Bridge Construction.—Prof. Paul Panayeff, of the Imperial Technical School, Moscow, Russia, now in this country, (Sept) writes the Secretary substantas follows,—

The object of the American Society of Civil Engineers—the advancement of engineering in all its branches—is, as I understand it, one quite scientific and practical. Believing this, I respectfully request assistance in a scientific undertaking, the aim of my commission in this country by the Council of the Imperial Technical School of Moscow and the Russian Government.

The recent wonderful progress of Americon engineering remains almost unknown in Europe, and even its true scientific principles are misunderstood by most of the European professional public. This fact is to be regretted in all respects. It delays the progress of one important art not only in Europe but partly also in this country. Besides this, many engineers and manufacturers here, who could with great ease compete with those of England and Belgium in construction of bridges in Russia and other countries of Europe, which more or less import their bridges, are not at present in position to try the business, because proposals will not be accepted from a country in which engineering is supposed to be conducted in quite an empirical manner.

Such regretful misconception of European professional men arises from the present state of American technical literature; it is quite poor in comparison with that of Europe, which is full of description of all constructions of some interest, with details and drawings on large scale. With a few exceptions, the works of American engineers are not described in such scientific manner, whence the foreign public is led to think that they are directed in an empirical manner and cannot answer the requirements of real art and science. This opinion is so established, that reports of commissioned experts on the progress of American engineering are discredited, particularly because these reports are not accompanied with sufficient data and drawings. The most valuable report of an eminent French engineer, Prof. Malezieux failed for this same reason, and the persons who, from theoretical points of view, have accepted his conclusions and those of other commissioned reporters, are accused of an attempt to pervert the public sense with accounts of constructions of a superficial character; because in Europe, as through the whole world, the public knows more of bridges, etc., which have failed than of others which stand and are perfect.

As, in my lecture, I advocate the superiority of American bridges and foundations, the counsel of the Imperial Technical School, and the Government, commissioned me to this country, in order that I might gather information about the state of American engineering in comparison with European. I have already seen and collected sufficient data and drawings to satisfy me, that in advocating the superiority of American bridge work, I have not made a mistake; but such is not sufficient to induce the professional public, influenced by the extensive European literature, to accept my conclusions, particularly as new writers have begun to ballast American literature with compilations from merely analytical and not really theoretical European works. As, in their compilations, the European practice is advocated, the public is led to believe that the original American practice, notwithstanding its large extension, has not given valuable results sufficient to satisfy the speculative mind, and that consequently the European practice, although defective, is most correct theoretically. I (and I am sure, the other engineers, similarly commissioned to this country), are of the contrary opinion; but in order that our views may be accepted by those who have not been in this country or who are not interested in such acceptance, it is necessary to have more materials than I have or can obtain in my short stay here, and therefore I must ask assistance in gathering information. This matter is in direct connection with the advancement of engineering and the true interests which are represented by your Society; the aid thus rendered in gathering information, will at the same time serve the interests of scientific and engineering art.

I wish to refer to principles and not persons, and for this reason I desire to have data of most of the different kinds and quality of construction; particularly of structures which have failed, for of such, generally, the experience is—for scientific and speculative investigation—more fruitful, than of those which have not failed. To make a true impartial comparison and to arrive at an instructive conclusion concerning different constructions of one class, it is necessary that the data shall be on one scale. With this view, before leaving Moscow, I had sheets of questions relating to bridges and foundations printed, copies of which I hand you. It is desirable to obtain information in reply to each question, which information will be found on the working drawings, or in the notes and specifications. I shall, however, feel obliged for every kind and extent of information relating to this matter. All such will be highly appreciated and fruitful, particularly if accompanied by drawings—preferably to large scale—or even sketches or details, either, with measures written on them, so as to give a good understanding of the peculiarities of construction.

All information gathered in this country, with that obtained in England, France and Germany, will be published in my report (in Russian and English), and I will send copies to them, who favor me with the data and information desired.

NOTE *by the Secretary*,—By the two circulars of Prof. Panayeff, (copies of which will be sent upon request), information is requested under the following heads.

I.—REGARDING FOUNDATIONS.

1°. Kind of building erected in foundation.
2°. Name, locality, and date of building.
3°. Name of engineer.
4°. Local conditions.
  A. Depth of water—
    at time of low water;
    at time of freshet. (H. W.)
  B. Velocity of current.
  C. Nature of soil—
    intermediate strata;
    bearing stratum.
5°. System and particulars of foundation.
  A. Method, say principles of constructing foundation and its protection from scour.
  B. Dimensions of foundations.
    a. Number of separate bearing beds, (supports).
    b. Dimensions of one bearing bed, (support).
      1. Surface, in square feet or meters—
        on bearing stratum;
        above water surface.
      2. The length (depth).
        in soil;
        from the bed of river up to low water surface;
        above the low water to the base of the superstructure.
6°. Dimensions of superstructure based on—
  A. Surface in square feet or meters of superstructure, on its base.
  B. The elevation of superstructure in feet or meters, from its base.
7°. Weight and pressure on support.
  A. Weight of superstructure.
  B. The value adopted for the adhesion of the ground per square foot of surface in contact.
  C. The pressure of the base, per square foot.
8°. Time employed in erection.
  A. Of one bearing bed (support).
  B. Of the whole foundation up to the base of superstructure.
9°. Expense of erection.
  A. Per unit—
    of one square foot or meter of bearing surface;
    of one foot depth in soil.
  B. Of one separate bearing bed (support).
  C. Of the whole bearing beds, (say total foundation up to the base of superstructure).
10°. Remarks and references.

II.—REGARDING SUPERSTRUCTURES.

1°. Kind and material of bridge.
2°. Name, locality and date of construction.
3°. Name of engineer or builder.
4°. Bridged space.
  A. Number of spans.
  B. Length of span between the centres of support.
  C. Clear span.
  D. Total length crossed by bridge.
5°. Platform or roadway.
  A. Position of platform in relation to main girder.
  B. Net width of platform.
  C. Length of cross-beams.
  D. Distance between cross-beams.
6°. Girder.
  A. System of girder.
  B. Number of girders.
  C. Dimensions of girder—
    span;
    depth of girder;
    number of panels;
    panel length.
7°. Weight of bridge.
  A. Weight of platform.
  B. Weight of one girder in tons.
    a. Booms—
      top chord;
      bottom chord.
    b. Web or bracing—
      ties;
      struts.
    c. Weight per lineal foot.
    d. Total.
  C. Lateral bracing.
  D. Total weight of the structure in tons.
8°. Data for calculation of strain.
  A. Principles or method of calculation.
  B. Data for live load in tons.
    a. Concentrated load;
      load of each pair of wheels;
      distances of axles.
    b. Uniformly distributed;
      rolling load per foot run.
  C. Values adopted for limited (working) stress, per square inch in tons.
    a. On wood—
      tension;
      compression.
    c. On wrought iron—
      tension;
      compression.
    d. On steel—
      tension;
      compression.

D. Ratio of ultimate resistance of material to the limited (working) stress, or the factor of safety.

9°. Time employed in erecting the bridge from beginning to end of work.

A. Time employed in erection of abutments and piers.

B. Time employed in erection of girders, etc.—
time employed in workshop;
time specially employed to connect all parts, and to put the whole structure in place;
total time.

C. Total time employed in erecting the bridge.

10°. Expenses.

A. Cost of piers and abutments.

B. Cost of girders, platforms, etc.—
cost, delivered in pieces;
cost of putting all parts together;
cost in finished state, up to opening for traffic.

C. Total cost.

11°. Remarks and references.

Communications may be addressed to Paul Panayefl, Professor of Civil Engineering, Imperial Technical School, Moscow, either direct, or "Care of the Secretary," here. It is important that such should be forwarded in time to reach him before January 1st.

Correspondence.

SEWERAGE.

BOSTON, Nov. 8th, 1876

Dear Sir:—In your issue of the 4th inst. you invite suggestions in regard to your re-publication of "Latham's Sanitary Engineering" with additions concerning American practice. It seems to me that something might with advantage be added to what is there given on Velocity and Discharge. Latham follows Weisbach, who in turn agrees closely with Prony, Eytelwein, and Du Buat.

But Bazalgette and Roe, in England, and Kirkwood and McAlpine, in this country, men whose experience certainly gives weight to any statements, offer rules so at variance with the older authorities, that they seem quite irreconcilable:

Kirkwood, for instance, modifies Prony's formula from

$$\text{Disch.} = 38.08 \sqrt{\frac{D^5 H}{L}} \text{ to } 38.08 \sqrt{\frac{D^6 H}{L}}$$

varying as the square root of the diameter, or in a 9-feet main sewer as 3 to 1.

Bazalgette quotes with approval (Proceeding of Inst. Civil Eng., Vol. XXIV), Mr. R. Stephenson's statement, that the formulæ of Prony, Eytelwein, Du Buat and others "rank among the most truthful that the professional man possesses * * * * and may be implicitly depended on." Yet to drain 500 acres, with a fall of 1 in 2000, Mr. Bazalgette's formula gives a sewer of less than one third the sectional area that would be required by Prony or Latham. Mr. Roe gives a smaller diameter still.

To one perfectly willing to bow to the authority of experience, it is hard to decide where to place his "implicit dependence." ELIOT C. CLARKE.

Contractors' Intelligence.

The Cincinnati Bridge Company have recently closed a contract to build a swing bridge of 390 feet span across the Minnesota river at Henderson, Minn., twenty-six miles from St. Paul. The price is near $10,000.

The contract for the construction of the Eastern Extension R. R. from New Glasgow to Canso, Nova Scotia, has been signed by the Commissioners of Public Works on the part of the Government, and Henry Abbott for self and partner. Active operations are to commence at once.

The following are the names of the bidders, and the amounts bid for the several contracts heretofore advertised in ENGINEERING NEWS:

For Steam Heating the 2d and 4th Ward School House, Milwaukee, Wis.; Jno. Davis and Jas. Creswell, Chicago, $6,853 for wrought iron boilers and pipe coil. Goodman & Mooers, Milwaukee, $7,000 for cast iron boilers and radiators. Jas. L. Judge, Milwaukee, $7,650 for cast iron; $7,200 for wrought iron. Papers to be sent to Council, by which awards will be made.

For Improvement of Asher street, LaFayette, Ind; Asher & Powers, LaFayette, Ind., Excavation, 25 cts. per cu. yd., Gravel, 35 cts. per cu. yd., Paving, 5 cts. per sq. ft. Tinkler street:—Owen & Wheeler, LaFayette, Excavation, 25 cts. per cu. yd., Embankment, 25 cts. per cu. yd., Gravel, 35 cts. per cu. yd., Flagging, 33 cts. per lin. ft., Stone Paving, 4½ cts. per sq. ft. Asher & Powers, LaFayette, Excavation, 25 cts. per lin. yd., Gravel, 35 cts. per cu. yd., Flagging, 35 cts. per lin. ft., Paving, 4¾ cts. sq. ft.

For Road Improvement, Bloomingdale & White Oak Road, Fayette Co., Ohio; P. F. Smith, Landon, Ohio, $2,400 for Sec. 1, (1 mile). Wm. Allen, Midway, Ohio, $2,670 for Sec. 2, (1 mile); same, $3,000 for Sec. 3, (1 mile). John A. Paul, Washington, Ohio, $3,325 for Sec. 5, (1 mile); same, $4,000 for Sec. 5, (1 mile); same, $4,000 for Sec 6, (1 mile). J. R. Snyder, Washington, Ohio, $4,000 for Sec. 7, (1 mile); same, $1,200 for Sec. 8, (3 miles). Daniel Simpkins, Belfast, Clermount Co., Ohio, $21,900 or $3,000 per mile for entire line. Contract was awarded to Mr. Simpkins.

For The Harbor Improvement, Sand Beach, Mich.; Hemenway & Hayes, Painesville, Ohio, Oak $13.; Pine $14; Iron 3¼c.; Stone $6; Framing $7.75. Farris & Garfield, Painesville, O., Oak $13 75; Pine $18; Iron 3c.; Stone $5.95; Framing $7.50. H. S. Dale, Chicago, Ill., Oak $12; Pine $20; Iron 3½c.; Stone $6; Framing $9; Steel & Smith, Detroit, Mich., Oak $13; Pine $30; Iron 3¼c.; Stone $6.50; Framing $8.50; Robt. J. Hackett, Detroit, Mich., Oak $15; Pine $25; Iron 3½c.; Stone $6.50; Framing $8.50; Chas. S. Barke, Saut St. Marie, Mich. Oak $16; Pine $18; Iron 3¼c.; Stone $6; Framing $8; Roys J. Cram, Detroit, Mich., Oak $19: Pine $30; Iron 4½c.; Stone $9; Framing $9.50.

For removing Wreck and Boulders in the Harbor; Chas. S. Barber, Saut St. Maria, Mich., for wreck $1,500; for boulders $3 per cu. yd. Hemenway & Hayes, Painesville, O., for wreck $2,200; for boulders $8 per cu. yd. E. P. Harrington, Detroit, Mich., for wreck $2,100; for boulders $12 per cu. yd. H. S. Dale, Chicago, for wreck $3,100; for boulders $15 per cu. yd. E. T. Williams & Co., L'Anse, Mich., for wreck $5,000; for boulders $15 per cu. yd. Roy J. Cram, Detroit, for wreck $3,950; for boulders $39 per cu. yd. Hiram Hill, Cairo, Ill., for wreck 5,000; for boulders $20 per cu. yd.

The Anglo-French Tunnel.

The company in whose hands is provisionally placed the construction of the railway and sub-marine tunnel which are to connect France with England by land communication has just finished for the season its laborious preliminary investigations. Owing to the state of the weather, these could only be efficiently begun toward the end of June last, and are now again interrupted by the autumnal fogs and mists of the Channel. The principal objects in view during the interval have been to obtain the requisite knowledge and material for framing accurate geological charts both of the various strata through which the inclined planes must pass which are to lead from the surface of the soil to the level of the tunnel itself, and also of those at the bottom of the sea through which the tunnel is to be pierced. The attainment of the first of these objects presented no particular difficulties, and consisted in simply working an artesian shaft at the fishing village of Sangatte, near Calais, to the depth of about 300 feet; and then, secondly, in proceeding to ascertain, by soundings across the whole concave basin of the Channel from shore to shore, whether the strata, as ascertained by the land shaft, came out and responded to the same under the sea, so as to prove, as far as could be, that they lay in regular succession and layers, and that no difficulties were to be apprehended, in boring the tunnel, from what miners call "troubles," or the upheaving or lowering of strata by internal convulsions. The laborious and difficult part of the above investigations consisted in the numerous soundings to be taken, the observations to be made to fix the precise spot on the chart, and above all to obtain specimens of the bed of the sea all the way across. The Channel is nowhere deeper than about 200 feet, but still, where the bottom is thickly covered with shells or sand, it was sometimes not easy to ascertain the precise geological formation underneath. The grand object of all is to ascertain whether a stratum of gray chalk, which is at once easily pierced and impermeable to water, stretches right across, without any "trouble," from one coast to the other, and of sufficient depth to contain the tunnel. For this purpose 6,148 soundings, made with a heavily-weighted instrument worked by a steam-engine and armed with a point of fine steel, were effective, sometimes at the rate of 200 per diem, and 2,514 specimens obtained. Last year when these investigations were first commenced 1,523 soundings were made and 753 specimens obtained, and now Messrs. Potier and De Lapparent, official engineers of the company, are engaged in classifying all these 3,267 specimens in order by their aid and the result of the boring to lay down the required chart previous to the final commencement of the great undertaking itself.

NOTES.

Specimens of rich copper ore have been discovered in the prison yard at Stillwater, Minn.

There will be 160,000,000 feet of logs cut on the Menominee river during this winter.

St. Paul is troubled with numerous law suits arising from alterations in the established grade of its streets.

Five panes of French plate glass, 69 x 134 inches, valued at $100 each, were broken while on their way to ornament a block in Minneapolis. The loss falls on an Indiana glass company.

The work of dredging the Hudson River below Albany has been discontinued. The channel is still in a very bad condition, and the larger boats experience considerable difficulty in making the passage. The trouble is caused principally by barges which lie three or four days in one place, around which the sand collects. When they leave, small hillocks are left in the channel.

Railway News.

The Karns City & Butler, Pa., narrow gauge road is open.

The Texas & New Orleans Road is now completed from Houston to Sabine.

The rails of the New Brunswick R. R. are now nearly all laid to Caribou.

The Sandy Run Road, from Hopewell to Bedford, Pa., is to be built immediately,

The International road will reach Austin by the end of this month.

The Southern Pacific R. R. Co. had last week about 600 hands at work between Goshen and Cross Creek grading roadway.

The extension of the East Brandywine & Waynesburg R. R. to New Holland, Lancaster county, Pa., is completed.

Track-laying has begun on the Henderson & Overton R. R., fifteen miles in length, and it will soon be completed.

The formal opening of the Columbus & Toledo road, between Columbus and Marion, Ohio, took place November 1.

The iron on the Wisconsin Central has been laid as far as the main Flambeau river and is proceeding rapidly.

The Wheeling & Alliance company have received all their iron for the track between Alliance and Southington, and are now laying a mile per day.

Work has been begun on the new steam narrow gauge railroad to Coney Island from Williamsburg, and it will be completed for traffic next spring.

The citizens of Newport, Ohio, are agitating the project of building a marrow gauge railway from Newport to a point up the river opposite New Richmond.

A large portion of the trestle work of the St. Paul & Sioux City R. R. near Mendota, has been filled in with earth, and the remainder greatly strengthened by needed repairs.

The grading on the Pembina Road between Portlandville and Calliope, Dakota, is about completed. The The road is now partially ready for the bridges, ties and rails.

The President and Superintendent of the Newcastle & Franklin R. R. are now making investigations with a view of extending the road from Stoneboro to Meadville, Pa.

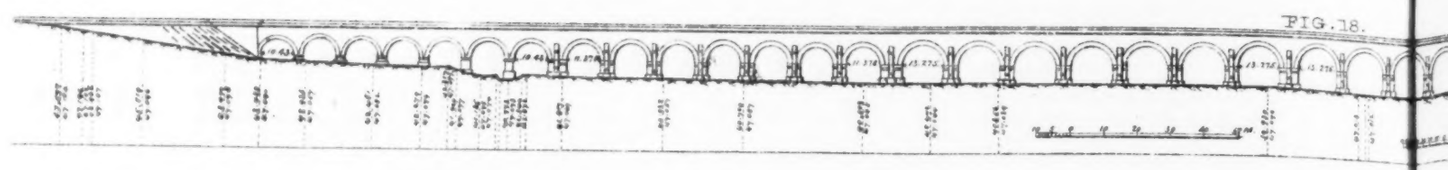
The Philadelphia & Atlantic City narrow gauge from Camden, N. J., to Atlantic City is to be commenced immediately, and it is expected will be finished by July 1, next. The length of the road will be 55 miles.

The Galt and Ione R. R., Cal., is about completed to Ione. The line will connect LaGuayra, the port of Venezuela with Caracas, and will remain under the superintendence of a couple of Belgian Engineers.

When lines now in course of construction are completed Victoria will have 670 miles of railway; New South Wales will have 687 miles; and New Zealand 830 miles. The day does not appear to be very remote when unbroken railway communication will be established between Sidney and Melbourne.

WATER WORKS, ANCIENT AND MODERN.

FIG. 18.



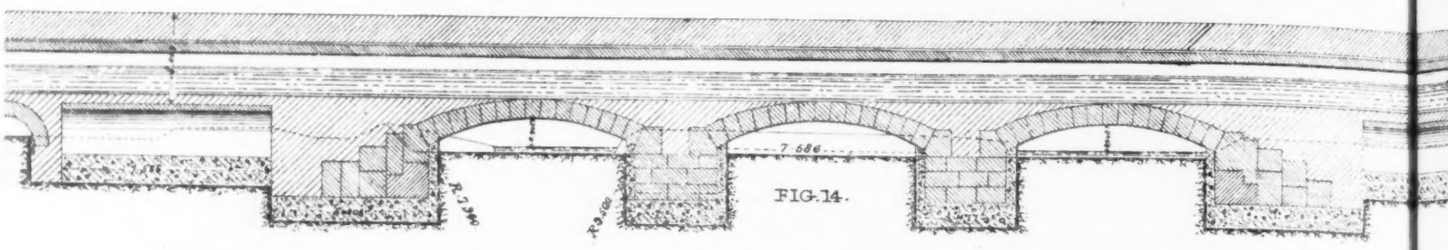


FIG. 14.

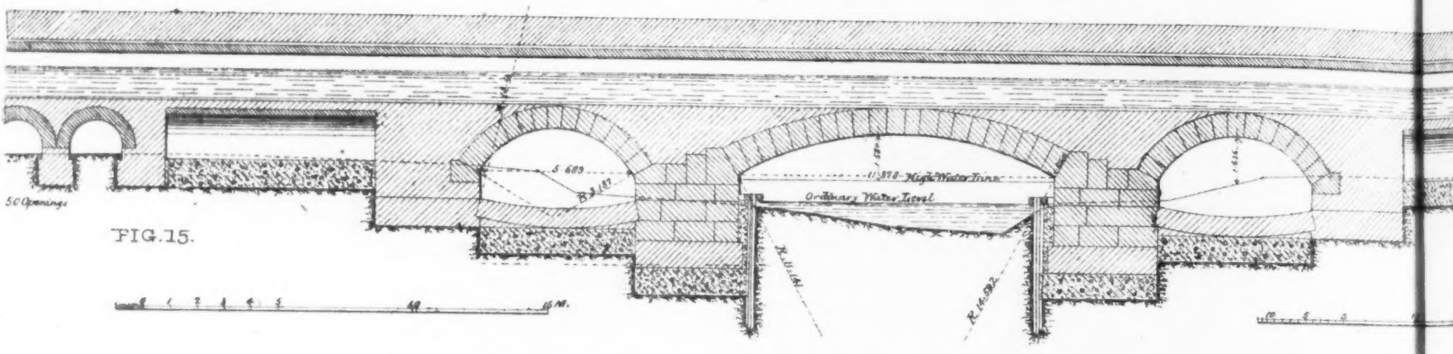


FIG. 15.

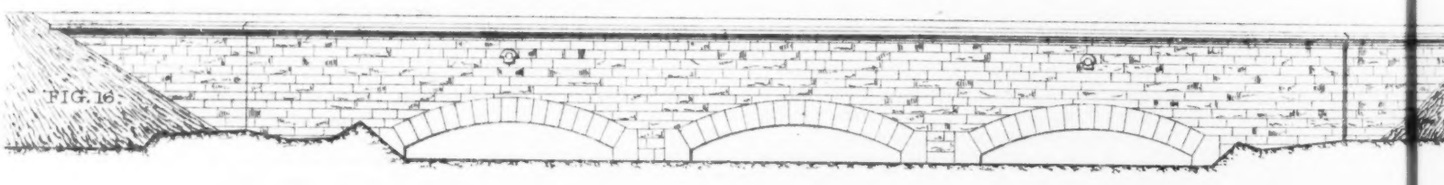


FIG. 16.

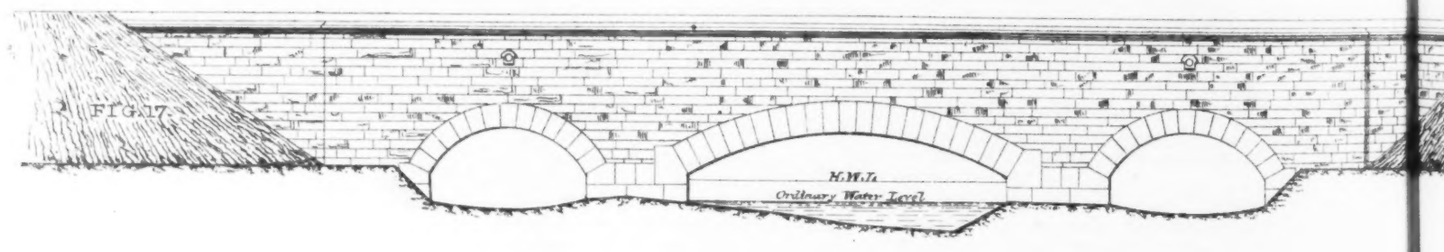
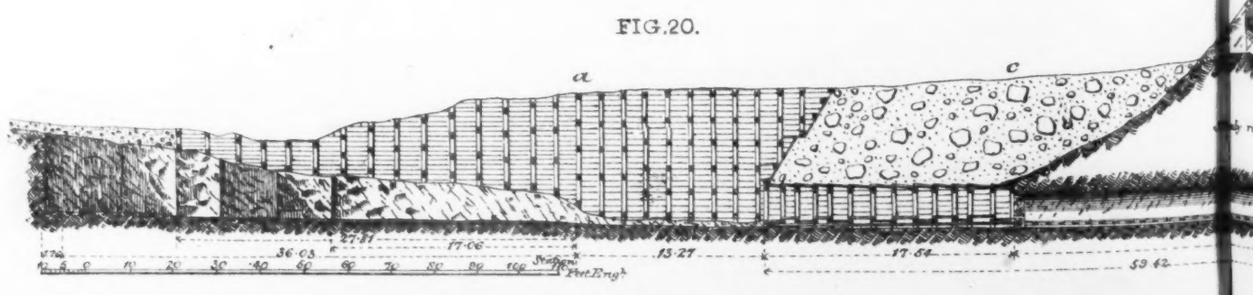


FIG. 17.

FIG. 20.



DETAILS OF VIENNA WATER WORKS.

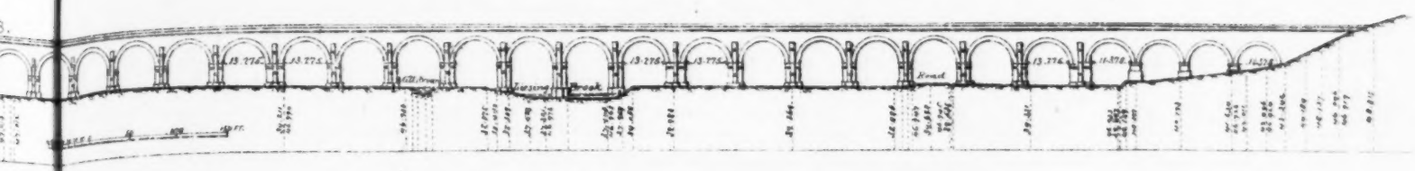
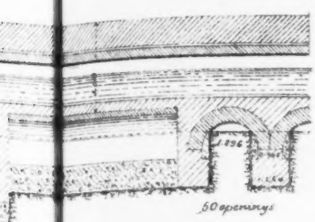
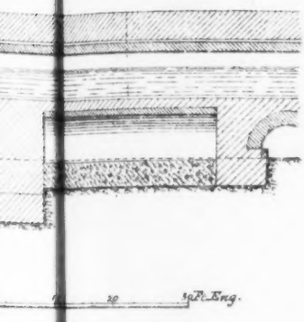
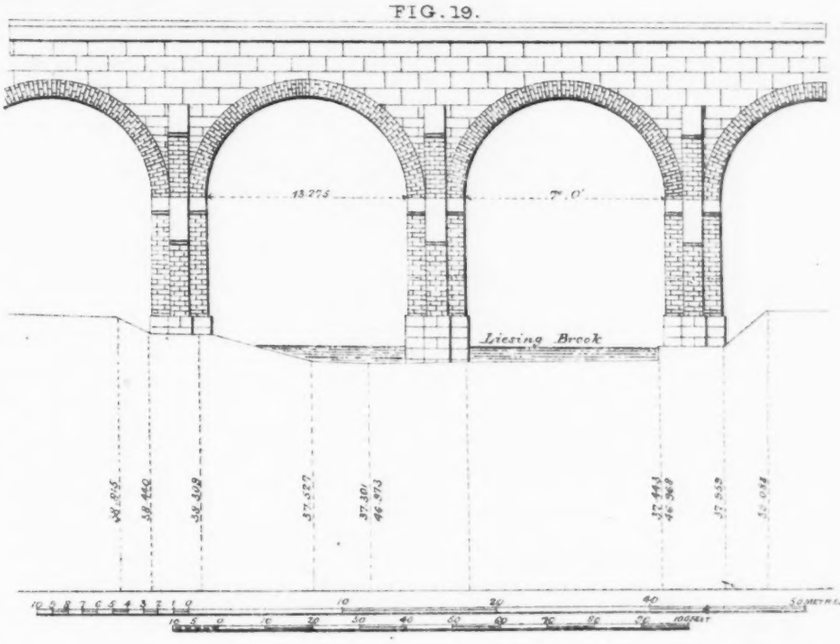
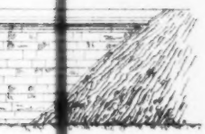


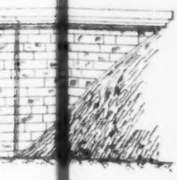
FIG. 19.











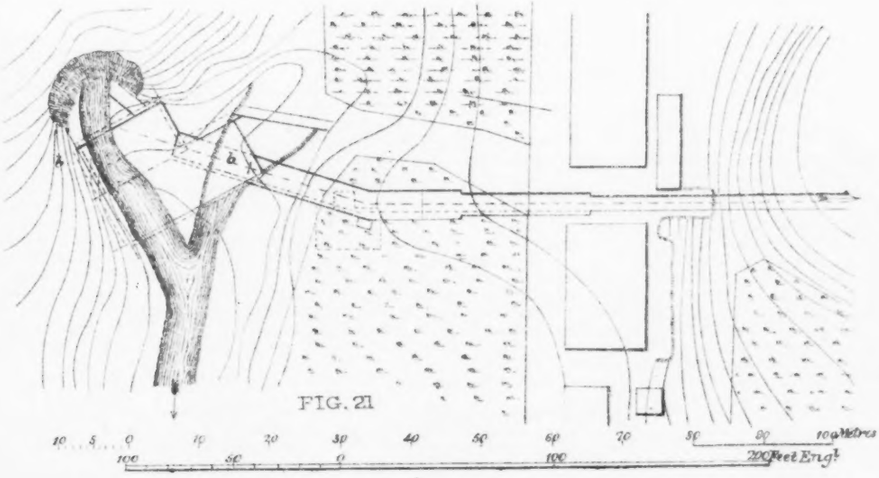


FIG. 21

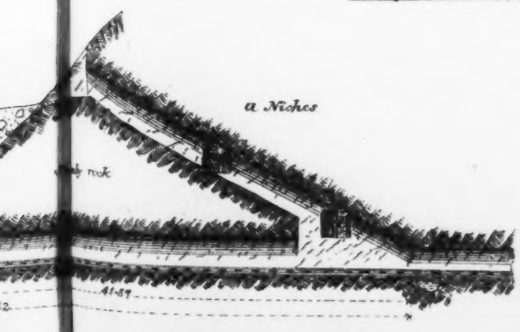


FIG. 22.

FIGS. 14 TO 17. DETAILS OF KALTENGANG AQUEDUCT.

FIGS. 18 AND 19. LIESING AQUEDUCT.

FIGS. 20 TO 22. WORKS AT KAISERBRUNN SPRINGS.

BRYANT & WESTON
ENG. NEWS. OFF. CHICAGO.

A New Method of Steam Traction on Canals.

A Paper read before the Civil Engineer's Club of the Northwest November 14, 1876.

BY W. SOOY SMITH, C. E.

Cheap transportation, interesting and valuable as it is everywhere, is especially so in the United States, whose vast and bulky surplus products have to be carried over great distances to the localities in which they are consumed. The following description of a new method of traction on canals is therefore presented to the Club, with the hope that it may attract sufficient attention to secure a full and free discussion of its features, whether they be good or bad.

It is the invention of Mr. Cook of Franklin, Tennessee, and may be described as follows:

A wooden rail track, double where the width of the canal permits and the traffic requires it, is laid upon the bottom of the canal resting upon piles where this is necessary—and firmly fastened to the bottom whatever may be its character.

Upon this tract is placed a "Tractor" to be used only as such, and carrying its fuel and machinery only, having attached to it and towing a number of burthen boats or barges. This "Tractor" to be built of plate iron after the most approved model and to be furnished with (preferably) two driving wheels with concave tires to fit the wooden rails of the track. The drivers for a "Tractor" of the size recommended to be say, 10 feet 8 inches in diameter—the iron rim to be so constructed as to carry a concave wooden tire in order to realize the advantage of the high co-efficient of friction of wood upon wood when wet, which Morin gives at 0.71, and which is the ratio of friction to normal pressure. The drivers are enclosed in water-tight chambers which exclude the water from the interior of the "Tractor." and the axles of the drivers are so held and supported that they can be raised or lowered to adjust them to the draught of the "Tractor."

Two guide wheels with concave tires similar to those of the drivers are placed upon a pivoted axle well forward, aligned with the drivers and running on the same track. They can be raised or lowered and so controlled by a steersman as to carry the "Tractor" around any curve that is likely to occur in a canal with any requisite speed.

The "Tractor" will contain water-tight compartments which can be filled by means of valves communicating with the exterior water and emptied quickly by pumps provided for the purpose.

These tanks are so connected with each other by means of pipes furnished with valves, that the quantity of water in each can be controlled at pleasure, and the draught and trim of the "Tractor" so regulated as to throw just the amount of bearing desired upon the drivers or pilot wheels. Or by the same means the "Tractor" can be lifted clear of the track whenever it is desirable to do so.

The "Tractor" is to be furnished with a rudder if this should be found necessary for steering it when it is free from the track.

The propelling power to be steam or such other motor as may be found preferable and so geared as to operate the driving wheel in any approved way.

The inventor recommends burthen boats built of corrugated tank-iron, the corrugations running lengthwise of the boat, to be of uniform width with the "Tractor" and of any desirable length. He suggests for the "Tractor" a width of 7 feet 8 inches, length 32 feet, and for the barges width 7 feet 8 inches and length 60 feet.

He thinks a barge of these dimensions and suitable draft will carry 50 tons and need not itself weigh to exceed 3 tons. This would make the dead weight not including the "Tractor" but about 16 per cent. of the useful load, while in frieght cars on railroads it approximates 100 per cent.

The rear barge of each train shall be furnished with stern of approved model to permit the water to pass from it smoothly and with least assistance. It will also be provided with a suitable rudder.

Each barge shall be provided with an automatic brake by means of which a train of any length can be easily and quickly stopped. These brakes are valves which are thrown out from the side of a barge like the fins of a fish.

When it is impracticable to so load all the barges as to give them the same draft, the heavier barges are placed in front and a movable apron is attached to the stern of each boat and adjusted to the bottom of the succeeding one to prevent a hurtful disturbance of the water underneath the train. These aprons to extend from below the stern of each boat to the middle of the bottom of the succeeding one.

Locks as now constructed can be used, but the inventor recommends locks especially adapted to the wants of his system and invites attention to the improved inclines in use on some of the English and Scotch canals as well as upon some of our own in New Jersey. If locks as they are now generally built are used, the "Tractor" will first be locked through and placed in position on the track of the level, pound or basin reached. The burthen barges are then locked through as many at a time as the lock chamber will contain, and the train is made up anew in rear of the "Tractor."

Pivoted spuds or guides are attached to the "Tractor" for the purpose of putting it on the track readily.

As the track will project but a slight distance above the bottom, other boats than those employed in this system may still be used and towed by the method now employed. The system as thus briefly described, seems to possess the following advantages.

1st. As compared with railroad transportation it has the merit common to water carriage in general, viz: The weight is borne by the water and the resistance from friction and to displacement is less than that to be overcome on railroads, There is also much less liability to accidents from derailments, collisions and the like, resulting in heavy losses. The cost of maintenance would also be less.

2nd. Actual experience with steam propulsion on canals has shown that under favorable circumstances as to dimensions and lockage, steam is more economical than animal power in the ratio of 3 to 1. A higher rate of speed can also be maintained. On the Aire and Calder Canal, the rate was 4·5 miles per hour without injury to the banks.

Where injury has been done to the banks of canals by the waves generated by boats moving at high rates of speed, this injury has been found to be confined to that portion of the bank extending from one foot below to eighteen inches above the water surface. This portion of the banks can easily be protected by a stone facing and this has been done on many of the canals on which steam propulsion is now used.

3d. As compared with the steam barges now commonly employed, the length of which is but from four to six times their width, the same cleavage of water has to be performed for the barge as will be required for the "Tractor" and its train And the same amount of carrying capacity is lost in the bow and stern of a steam barge if these are made of forms adapted to high rates of speed, as that which is sacrificed for the same end in the system under discussion for a whole train of boats. If the bow and stern of a barge are made very full to give it great carrying capacity, the model becomes so blunt and tubby as to produce hurtful waves and increase resistance to towing.

It has also been found that the water in canals is greatly agitated by any form of screw or wheel used for propelling a boat. It is claimed that the drivers used in this system will produce a minimum of this agitation.

4th. If a steam barge propelled by paddle wheel or screw is used to tow a train of burthen boats, it is found that within the distance at which it is necessary to place the train from the propellor in order to make it steer well, the back current produced by the screw or wheel is split by the bow of the leading boat of the train and is thrown off in a very hurtful way upon the banks. This back current also increases the resistance to be overcome, and makes the propeller to this extent work against itself.

5th. If we compare Mr. Cook's system with that which proposes a railroad track on each side of the canal upon which locomotives can be run drawing trains of boats; it will appear that the two iron tracks on shore will cost a great deal more than the wooden ones on the canal bottom in the first instance and also more for maintenance, as wood will answer best for the track under water while iron or steel will be required on land.

There is also a large amount of excavation and embankment required for the construction of the road-beds for the tracks on the sides of the canals, whereas the bottom of the canal is already prepared to take the tracks of Mr. Cook's system.

When a train of boats is drawn by any power located on the bank this power has to be applied in a direction oblique to the path of the train, the tendency of the train to move in this direction being corrected by the rudder. There is a large percentage of power lost by applying it in this oblique direction and from the resistance developed by the rudder. This loss is avoided in the system under discussion inasmuch as the train follows the "Tractor" in the line of its draught.

The locomotive on the bank performs no function except pulling the train, the "Tractor" leading its train of boats opens the way through which they pass with a minimum of resistance.

6th. There remains what is known as the Belgian system, or traction by means of a wire rope lying on the bottom of the canal and wound over a drum or wheel on the propeller operated by steam. This system has been in successful operation for some years and certainly possesses many advantages. But Mr. Cook claims that his system is superior to this, being cheaper as to first cost and liable to less derangement, breakage and accident. He also thinks that it must be difficult to keep a wire rope in place on the curves that occur in many of our canals.

The following is the inventor's estimate of the cost of towing by his system on the Illinois and Michigan canal:

"Theoretically to move 1200 tons with a displacement of forty feet (area of cross section of submerged section of boat) at the rate of 12 miles per hour, requires a force of about 27 horse power. Allowing 40 horse power which is an increase of nearly 50 per cent., and allowing 4 lbs. of coal per horse power per hour, we have 160 lbs. or say two bushels of coal per hour run, including reasonable stoppage. If we estimate the speed at 10 miles per hour including stops we shall make 100 miles in 10 hours with an expenditure of—

20 bushels of coal at 10 cts.	$2.00
Engineer $3, fireman $1.50, 2 train hands $3	7.50
Wood, oil, etc., say	.50

Cost of moving 200 tons dead weight, and 1000 tons actual freight 100 miles $10.00

Allowing for handling freights and return transportation of empty boats $90.00 we have for the cost of moving 1000 tons 100 miles $100, or one mill per ton per mile."

COST OF MOVING FREIGHT ON CANALS BY STEAM.

Name of canal or river.	*Cost per ton per mile.*	*Authority.*
Gloucester & Berkley	1-12 to 1-16 of a penny.	Leader Williams
Grand Junction	.184 "	Herbert Thomas
Aire & Calder	.473 "	W. H. Bartholomew
Regents	.916 "	Edwin Thomas
River Thames	.333 "	Beardmore
Holland Canals	1-14 "	C. I. Appleby

The wide range in cost of steam tonnage as shown by the above table is attributable to the difference in the characters of the canals and in the boats and machinery employed.

The Gloucester and Berkley being a ship canal with but one level, sixteen miles in length and of ample depth and width, gives an exceptionally low rate, as do the Holland canals which have but few locks.

The cost of towing by animal power on the Erie canal has been frequently reported at one-half cent per ton per mile.

The advantages of Mr. Cook's system as compared with other methods of traction on canals having been briefly pointed out as claimed by him, the attention of the Club is invited to the following objections to it which present themselves:

1st. The system necessitates the use of trains of burthen boats. This has been found impracticable where the levels are short and locks frequent. In a discussion of steam power on canals by the British "Institution of Civil Engineers (Minutes of proceedings, Vol. XXVI, session 1866–67 N. S.) Mr. Leader Williams, Jr., said that on the river Weaver steam barges towing trains of boats had been tried; but it was found that even with double locks, the delay with steam tugs towing several barges was so serious, and so interfered with the traffic that that plan had to be given up. Steam barges, carrying their own burthens were then introduced and succeeded. But on canals with long levels or basins this objection measurably disappears.

2d. The size of the prism of the canal must also be taken into the account in estimating the advantages to be anticipated from the introduction of any such method of traction as the one proposed by Mr Cook.

Where the width and depth of the canal are very great as compared with the width and draught of the boats to be employed, the hurtful resistances developed at high rates of speed are far less formidable than in the case of canals which are narrow and shallow in the same comparison.

The usual ratio between the areas of cross section of the submerged section of a canal boat and that of the prism of the canal is from 4 to 7. Where the latter or any greater ratio holds, experiment demonstrates that the case may be considered analogous to that of a boat propelled through open water.

While this system may succeed admirably in deep, wide canals, it may fail in narrow shallow ones.

3d. For the successful working of Mr. Cook's system the track must of course be kept clear of obstruction from mud, grass, etc., which frequently accumulates in many of our canals, and sometimes to such an extent as to seriously interfere with the working of screws, paddles, and the wire ropes used in the Belgian system.

Notwithstanding these drawbacks, all of which only exist in canals of a certain character, Mr. Cook's system seems to possess such unusual merits as do not at first appear, and to merit the close study and thoughtful consideration of the civil engineers of our country.

And it is with the hope that a searching examination and discussion of its features good and bad may be stimulated, that this paper is respectfully presented.

Improvement of the Lower or Des Moines Rapids, Mississippi River.

BY MAJ. E. HUDSON WORRALL, U. S. ENG.
(Asst. Engineer in Charge).

GEOLOGICAL FORMATION OF THE RAPIDS.

It has somewhere felicitously been said of our great artery, along whose channel course the supplies for the support, pleasure and profit of a large proportion of civilized humanity, that "This giant stream, with its head shrouded in Arctic snows, embracing half a continent in the hundred thousand miles of its curious net work, and coursing its majestic way to the Southern Gulf, through lands so fertile that human ingenuity is overtaxed to harvest their productiveness, has been given by its Immortal Architect every mile of it into the jealous keeping of this Republic," and the representatives of this Republic in Congress assembled, taking an unusually ample view of the subject, did, by act of June 23d, 1866, authorize its agents, the engineers of the U. S. Army, to make another hydrographic survey of the two most serious obstructions to the navigation of that "giant stream," the first of which, known as the "Lower, or Des Moines Rapids," occurs about fifteen hundred miles from the mouth, and will form the subject of our sketch.

Geologists speculate that the great section of country ranging north of the Ozark Mountains, in remote ages, was an immense clear water lake, and that at "Grand Tower," below St. Louis, the water has apparently cut through nearly three hundred feet of rock. This erosion, something similar to what is known to be taking place at this time at the edge of the rocks over which thunder the volumes of Niagara, has gradually worn thechannel of the Mississippi to its present dimensions.

The same phenomenon shows where the bluffs, receding at right angles from the river below the town of Montrose, and near Nauvoo, that historic location of the earlier trials of Jo. Smith's wonderful fanatics—and seems to indicate that the rapids known as the "Des Moines" have been formed by a gradual erosive process, extending through ages, until the present eleven and a-half stretch of tortuous, dangerous and sometimes impassible navigation has been formed, making a gentle and almost uniform slope from Montrose to Keokuk, with a fall of about twenty-two feet, over which the waters of the river, widening out to a mile and more, flow smoothly and swiftly with a mighty current on their way to the Gulf.

For years the problem of improving the navigation of these rapids has been studied by the best of engineers and steamboat men along the river, and as early as 1838 Lieut. Robt. E. Lee—afterwards the celebrated leader of the armies of the Confederacy—made a survey for the purpose of solving this problem, but nothing was done at that time.

The next investigation of this knotty subject was made by Gen. Samuel R. Curtis, a distinguished engineer of Keokuk, in 1849, who incorporated a company for the purpose of building a canal around the rapids—the general idea of which has been actually carried out. No work was ever performed under this organization.

In 1854 Lieut. G. K. Warren, U. S. Engineers, made another survey of the rapids, and recommended a channel improvement. Shortly afterwards Major J. G. Floyd, a Government Agent, in attempting to carry out this plan, succeeded in partially improving the Spanish and Lower chains, but the work was found so expensive and the result so meagre in proportion to the money expended, that Congress refused any further appropriations, and the work was abandoned.

In the meantime the great rebellion had broken out, and it was not until 1866 that this subject was again brought before Congress and action taken thereon.

The carrying out of the plans for the amelioration of this obstruction, and at times impassable barrier to the transportation of the endless and immense products of a great and prolific section of the country, was entrusted to the care of Brevet Major General J. H. Wilson, then Captain of Engineers, U. S. A., who, fresh from the war, the laurels of his conquests thick upon him, entered upon his duties with the dash and vim characteristic of the great cavalry captain that he is. Inspiring his subordinates with the same energy that had hitherto marked his eventful career, the preliminaries of the survey were pushed through rapidly and accurately. The comparison of the different plans and the details of his own most excellent plan were submitted to and discussed by a board of learned and experienced engineers, and the final conclusion, which embraces almost the very recommendations of Gen. Wilson, with some modifications of details, at length arrived at was as follows, which embodies the General's plan and the changes recommended by the board:

* * * The construction of a lateral canal extending along the Iowa shore from Keokuk to the village of Nashville, a distance of seven and six-tenths miles, and that the improvement should be completed to Montrose by making a through cut two hundred feet wide and five or six feet deep, along the natural channel of the "Upper Chain." That the dimensions of the canal should be as follows: length seven and six-tenths miles; width on surface three hundred feet; depth at lowest stage, six feet; with two lift-locks and one guard lock, each three hundred and fifty feet long and eighty feet wide on top; and that the embankment should be made twenty feet wide on top, be carried up to four feet above the highest known flood, and be covered inside, outside, and on top with a riprap of broken stone.

The board of engineers recommended certain changes in the details of the above mentioned plan, viz: that the embankment be reduced to ten feet in width on top, with a rip rap covering two feet thick, to be carried two feet above extreme high water instead of four feet; the prism of the canal to be three hundred feet wide in embankment but reduced to two hundred and fifty feet in excavation; the minimum depth of water to be five feet; maximum depth eight feet.

"The recommendations of the board were concurred in by the chief of engineers, and approved by the Secretary of War, and the officers in charge directed to proceed at once to carry out the plan adopted."

This is a summary of the plan, and it was estimated that it would cost three millions three hundred and ninety thousand dollars, which estimate, if Congress had promptly appropriated the desired sums and not pottered along with inadequate and petty proportions of the amount of money known to be required, would have been amply sufficient. But the political antagonisms of the lower House, the numerous demands on the public Treasury to satisfy the diversified wants of a country embracing three-fourths of a continent, and the apparent impracticability of supplying all the demands of such an extended constituency invariably caused the different committees through whose hands the appropriation bills passed to cut down the amounts asked for from fifty to seventy-five per cent. This, though it has been the custom of Congress for years and in some cases may be the proper method, has been unfortunate for this improvement, owing to the peculiar nature of the work. Its magnitude; the dangerous casualties to which it was liable, running alongside of the largest river on the Continent—a river known to be subject to immense and dangerous floods at uncertain seasons of the year, floods that carry disaster and destruction to millions of dollars worth of property, and frequently hundreds of lives, which should have been incentive enough to our Representatives to have filled the estimates of the officers in charge and enabled them to carry out their plans and push the work to completion as rapidly as possible.

In this connection Gen. Wilson reports as follows; "Contemplating the immense trade of the upper Mississippi valley, through its natural channel, the Mississippi river, we must come to the conclusion that the obstructions at Keokuk and Davenport are the great drawback of the growing States bordering on the river, and that the damaging influence of those rapids must necessarily increase with the constantly increasing population."

To represent the necessity of the proposed improvement in dollars and cents is, from the nature of the problem simply impossible; but it is believed that the work is National and not local or sectional.

A simple calculation will show that the improvement of the rapids of the Mississippi will decrease the cost of transportation by increasing competition between the carriers, thus adding greatly to the wealth of the entire Northwest and removing an oppressive tax from the Eastern consumers of its products.

The dangerous places of the sea coast are marked by light houses and are provided with harbors of refuge at the national expense, for the benefit of commerce not exclusively our own. It seems then nothing more than justice that the general Government should authorize and provide the means for the improvement of a river in which our own people are exclusively interested, and in the navigation of which nearly every material interest of the entire country is concerned."

PREPARATIONS FOR ACTIVE WORK.

After instructions had been received from Washington, no time was lost in advertising for proposals for constructing the canal or section work. And at a letting held in Davenport on the 4th of September, 1867, Messrs. Henegan & Son, of Mt. Vernon, Ohio, were awarded the contract, they being the lowest bidders out of twenty-eight competitors.

Seven hundred thousand dollars having already been appropriated for this work, directions were received to enter at once into contract with the successful bidders: who, upon furnishing the required bonds and signing the proper papers, were ordered to start work without delay.

In compliance they began at the upper end of the canal, at Nashville, on the 8th of October, 1867, by building a temporary guard bank from the shore at the head of the guard lock, out to the line of the embankment, preparatory to extending down the river the outside embankment and rip-rap wall.

The great work was now fully inaugurated. Details of plans were considered daily; the route of the canal accurately laid out; property required for its construction surveyed and purchased from its owners; county roads and railroads changed where they interfered with the progress of the work; hundreds of men and teams employed blasting rock and excavating earth, which was transferred to the end of the embankment, making it stretch its slow and sinuous line down the river towards the outlet lock at Keokuk. Everything seemed working advantageously.

Meanwhile advertisements were published asking proposals for the work on locks, which was divided into five classes, stone, cement, iron, lumber and labor.

The work was duly awarded to the respective lowest responsible bidders, but as all of the money on hand was pledged to the section work, the lock contractors were unable to proceed until the next appropriation was received from Congress, and it was not until August 17, 1868, that Mr. E. Owen, the successful bidder for labor on the lower lock was able to get to work. Then however, he started the construction of his cofferdam which was formed principally of earth protected by a rip-rap covering of stone, with a timber cofferdam closing the lower end.

This lock was located entirely in the river, and in order to hasten the completion of the improvement, it was decided to enclose the whole area required for its construction in a cofferdam, proceeding with the work at once, and not to wait for the extension of the river embankment. The upper end of the dam was an earth bank protected by rip-rap, which extended into the river until it met the line of the proposed main bank. Then by building down as far as the foot of the lock where the masonry of the pier began, to finish the balance with a timber cofler filled in with earth and gravel—in this way a portion of the main bank would be built, forming at the same time a side of the cofler. This was successfully accomplished, and by the 15th of November, 1868, Mr. Owen had the whole area enclosed and pumped out.

But now happened one of those difficulties predicted in the construction of this work. The river began to rise and scarcely had the bottom of the dam been exposed to the curious gaze of the employes when in order to save the structure, which was twelve feet high and only ten feet wide, from being crushed by the rising waters, it was found necessary to flood it. In a few days, however, the river receded. The dam was successfully pumped again and with the exception of a few leaks and threatenings of breaks, the work of excavation for the foundation of the lock was carried on continuously until the night of December 31st, 1868, when an ice gorge forming in the river just outside of the dam raised the timber coffer bodily from the rock bottom, the waters rushed in, the dam filled and further operations ceased temporarily.

(*To be continued.*)

Water Works, Ancient and Modern.*

BY E. H. D'AVIGDOR.

(Concluded from page 360.)

Infinitely more imposing, though hardly more troublesome in its execution, was the great aqueduct of Baden, consisting of 43 principal openings of from 30 feet to 42 feet span, besides a number of subsidiary and lower ones which were covered up by a bank. This work is exactly half an English mile, long and no less than 90 feet above the bed of the Schwechat. It crosses the valley just above the populous town of Baden, famed for its sulphur springs, to which many of the Viennese resort during the summer months. The piers are constructed of faced and coursed rubble with ashlar quoins and on ashlar plinths; the arches are turned with six rings of bricks, the spandrils are also coursed rubble, and there is a string and parapet course of ashlar above, the extrados of the conduit being grouted and flushed in with rough concrete, and the whole surface then paved, the joints being run with cement. Handsome buttresses of ashlar support the piers. The whole structure, crossing as it does a park-like valley dotted with villas, and close to the palace of the Archduke Albert, which appears on the hillside to the right, presents a most imposing appearance. It was erected in the short space of two seasons, the first season having been cut to waste by the delay in obtaining the necessary ground and the dilatoriness of the sub-contractor. Great difficulty was here experienced, as the Exhibition buildings, which were at that period being hurried on at any cost, absorbed all the available supplies, and even the best brick manufacturers found it difficult to resist the enormous prices offered them for delivery at the Exhibition building rather than at the water works.

The next important aqueduct is that of Modling, to the same scale as the old Roman aqueducts of Marcia and Claudia. This is much shorter, the valley it crosses being in fact a mountain gorge; it has only five openings, but they are no less than 9 klafters in Austrian, or 56 ft. 6 in. English span. It is about 4 ft. higher in the centre than that of Baden, and is mostly constructed of brick, there not being a sufficient quantity of good rubble available. The conduit, emerging from a tunnel, immediately crosses the aqueduct, and then plunges into a second tunnel under the celebrated Lichtenstein Park; the whole of the material used in construction had, therefore, to be raised from the valley below, and for this purpose four huge scaffoldings had to be erected, each nearly 100 ft. high, and put together with the heaviest mast timber. The stone was raised by double winches, pulleys, etc., the bricks by that excellent method of an endless chain, carrying buckets, something like the chain and buckets of a dredger. In high winds it was found impossible to work on these scaffoldings, and the greatest precaution had to be used to stay the centres of such large arches springing at a height of from 50 ft. to 60 ft. above the valley.

The aqueduct of Liesing, which crosses that busy little manufacturing place close to the huge brewery, is the longest of all, viz., 900 yards English; it forms a very interesting object when seen from the railway, but needs no further description, as its construction is very similar to that of Baden. The Mauer aqueduct is remarkable only from its being built on a curve; in every other respect it is a much less important structure.

Some of the most difficult and interesting works are, however, buried away out of sight, and will rapidly fall into oblivion. For from the end of the Kaiserbrunn tunnel, near Hirschwaug to Ternitz, a distance of about 10 English miles, no one passing over the line would notice anything particular, nor in fact be aware of the existence of a conduit at all, except from the succession of handsome retaining walls, near the river Schwarzau. Yet this section presented many difficulties. In many cases the centre line is wedged in between the river, road and railway; it frequently lies in the former river bed; at other places it crosses swampy meadows which are saturated from the Schwarzau through the gravelly subsoil. The river walls were executed under most troublesome conditions. We were constantly working in the water; we had rock to deal with and did not dare to use powder or dynamite, except at certain hours of the night, because trains were constantly passing within range, and the high road had to be kept open for traffic, although our centre line was sometimes exactly under the middle of it. The river walls were constructed so that they supplied us with one abutment for the aqueduct at the same time; heavy cofferdams were used, and the water exhausted by steam power. Even this was often insufficient to keep the bottom dry, as the gravel subsoil, which fills the valley in many places to a great depth, allowed the water to rise again as fast as it was pumped out; in fact, through the increase of the head outside, the more we pumped the more we got. In these cases the bottom was dredged out and the foundations laid with concrete behind an apron of piles, after which the masonry could be proceeded with. In the park at Reichenau the whole soil was constantly saturated with water to within 18 in. of the surface, as the foundation was 12 ft. deep there was a head of 10 ft. 6 in. to contend with; here the whole of the canal was executed in concrete, the side walls being run with boxes or small cofferdams, and the arch being turned over a full centre or drum. Even this ticklish work has been perfectly successful, there being now no crack, settlement, or perceptible leakage whatever in this length of concrete or in any others.

Far from having been constructed, like the Roman aqueduct Marcia, without mortar, one of the principal reasons of the success of the work and the trifling nature of the repairs necessary is no doubt the excellent quality of the limes and cements employed.

Careful trials were carried out with scrupulous accuracy on every description of lime and cement before it was admitted to the works. On arrival of a specimen it was carefully filled into a box containing one cubic foot and weighed, the mean of several experiments being taken. It was then screened through a fine sieve and weighed again, it being supposed that the unburnt or vitrified particles or any stones would not pass through the sieve. The mean weight of the screened lime or cement per cubic foot was established as the standard which was to be paid for. Cylindrical vessels were then moulded with the cement, the necessary water being added in very small quantities; the vessels themselves were immediately filled with water and allowed to stand; if they gave way the lime or cement was refused. Sundry blocks were then formed, first of pure lime or cement, then with one-half, two-thirds and three-fourths fine, clean river sand, and all these blocks were tried both for extension and compression. Only after all these ordeals had been successfully borne was the material accepted for the works, and during the progress of the deliveries frequent trials were made to see that the quality came up to the first handed in. The greatest precaution was used to prevent any but accepted limes and cements being used on the work, and this was insured by the schedule prices of all masonry being exclusive of cement or lime, which was paid for separately by weight. Material arriving by road or rail had to be unloaded into one of the numerous temporary stores erected along the line for the purpose, there examined, measured, and weighed by the agents of the municipality, and as it was required on the works it was handed over to the contractor, who only received payment for the quantity thus handed over by the municipal agent. It was, therefore, the contractor's interest to deliver only the very best limes and cements, and if he had used any other material on the works but what had passed the municipal agents, he would simply have lost the price of it completely. It is a fact which every engineer ascertains by experience, that one of the greatest difficulties attending the execution of work is to prevent sub-contractors and gangers using inferio limes and cements or any stale mortar which is handy. The only way to prevent this abuse is to make it every one's interest, as much as possible, to use none but that approved and passed. The precautions adopted by the municipality of Vienna were certainly excessive, and frequently proved a hindrance to the progress of the work. As an example of this, I may mention that the contractors intending to erect a temporary stable close to the Baden aqueduct, provided some ordinary

* A course of papers delivered at the Austrian Institution of Engineers and Architects, December, 1875, and January, 1876.

TABLE No. III.—SHOWING SCHEDULE OF THE PRINCIPAL PRICES PAID ON THE VIENNA WATER WORKS, 1870—1875.

No.	DESCRIPTION.	FROM	TO
		s. d.	s. d.
	EARTHWORK.		
1	Excavation for pipe trenches in the town and suburbs, including strutting, timbering, fencing and lighting.....cube yard	0 5½	0 5½
2	Filling in ditto..... "	0 1	0 1½
3	Excavation from side cutting, including filling in, stamping and making up bank.....cube yard	0 8	0 8½
4	Excavation for main conduit of aqueduct, including strutting, timbering, filling in, stamping, making up bank, and all leads up to 210 yards..... per cube yard		
	(*a*). Light soil, sand, etc.....	1 0	1 2
	(*b*). Heavier soil, clay and gravel.....	1 6	1 10
	(*c*). In boulders and rock requiring powder.....	2 2	2 6
	(*d*). In saturated soil, including cofferdams and pumping.....	2 4	2 10
	(*e*). In " " requiring constant steam pump.....	4 0	4 6
5	Excavation in tunnel per yard formed irrespective of material and including all plant, timbering, dynamite, ventilators, etc.....	30 0	32 0
6	Leads over 210 yards are paid for at the rate of 1.4 (1 4-10*d*.) for every yard carried an additional 200 yards, no fraction under 40 yards being counted.		
7	In cases where pumping was not provided for, the men employed are paid per day.....	..	2 2
	MASONRY EXCLUSIVE OF LIME OR CEMENT.		
8	Rubble masonry in foundations, walls, abutments, and spandrils in mortar, ... per cube yard	7 1	8 2
9	Facing ditto in addition..... per square yard	6 0	6 4
10	Concrete in foundations..... cube yard	7 3	7 11
11	Dry rubble masonry..... " "	6 0	6 4
12	Rubble masonry in arches..... " "	12 6	13 0
13	Brickwork in foundations and abutments..... " "	14 0	14 0
14	" arches up to 36 ft. span..... " "	16 0	17 0
15	" " exceeding 36 ft. span..... " "	26 0	26 0
	N.B.—All prices for masonry and brickwork, including staging, centres, timbering, etc.		
16	Coursed and faced ashlar.....per cube foot	2 0	2 2
17	Cut and dressed ashlar in quoins, cornices steps, etc..... " "	3 2	3 6
18	Pitching 18 in. thick.....per square yard	4 6	5 0
19	" 9 in. " ..... " "	3 0	
	MISCELLANEOUS.		
20	Coat of Portland cement inside canal and polished three times, per sq. yard	1 8	
21	Piles 10 in. by 10 in. including driving.....per lineal foot	0 9	
22	Sheet piles, including driving..... " "	0 5½	
23	Two-inch planking.....per sq. yard	2 4	
24	Smith's work.....per cwt.	30 0	
25	All hydraulic lime..... "	2 2	
26	All Portland cement..... "	5 0	
	All prices include delivery on the works and working up. They are fixed by the average premium on gold (12½ per cent.), and include the percentage demanded by the contractors over the original schedule.		

TABLE No. II.—SHOWING THE QUANTITIES OF HYDRAULIC LIME AND PORTLAND CEMENT USED IN THE CONSTRUCTION OF THE VIENNA WATER WORKS, WITH THE STATIONS OF DELIVERY AND NAMES OF MANUFACTURERS.

HYDRAULIC LIME.

STATION, OR MAGAZINE.	*Saullich*	*Egger.*	*Curti.*	*Kink.*	*Lenbe.*	*Leithe.*	*Sartori.*	*Tuch.*	*Ohrfanal.*	*Kraft.*	*Ohrenstein*	*Pittel & Cie*	TOTALS.
	Austria (Tyrol.)	*Austria (Tyrol.)*	*Austria (Vienna.)*	*Austria (Tyrol.)*	*Upper Austria.*	*Upper Austria.*	*Austria.*	*Austria.*	*Hungary.*	*Austria.*	*Hungary.*	*Austria (Tyrol.)*	
	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.
Payerbach...	35.85	5690.75	54298.81	4786.93	....	....	57548.32	665.61	16703.65	4137.34	....	1020.70	144887.96
Gloggnitz....	173.18	....	57034.14	5502.84	....	....	9021.72	871.46	11790.97	1846.41	....	....	86240.72
Ternitz.....	807.71	11580.46	88837.65	37119.34	....	....	1567.64	5606.65	18906.62	10564.00	....	....	174990.07
Fischau.....	568.34	....	101552.28	2807.30	...	....	....	....	336.85	...	....	....	105264.77
Matzendorf..	153.54	....	56488.00	986.07	....	....	....	....	324.71	....	2091.72	181.99	60226.03
Leobersdorf.	20963.53	20166.11	40144.60	8889.04	....	....	1018.19	5585.62	....	11769.27	184.48	359.58	109080.42
Liesing.....	18745.29	83432.04	14082.27	30037.37	11178.04	3181.28	17.92	17964.63	165.64	26847.35	1776.42	872.66	208300.91
Totals.	41447.44	120869.36	412437.75	90128.89	11178.04	3181.28	69173.79	30693.97	48228.44	55164.37	4052.62	2434.93	888990.88

PORTLAND CEMENT.

STATION OR MAGAZINE.	*Saullich.*	*Curti.*	*Escher.*	*Longuetti.*	*Desire Michet.*	*Knight.*	*Burham.*	*Case-bourne.*	*Dickerhoff*	*Espenchied*	*Lothary.*	*Ohrenstein*	TOTALS.
	Austria.		*Austria (Triest.)*	*France.*		*England.*			*Germany.*			*Hungary.*	
	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.
Payerbach ...	11550.87	5586.66	5497.61	5433.61	345.11	468.22	2776.99	133.04	6872.59	4237.71	814.21	1856.02	41572.64
Gloggnitz ...	11705.08	7404.96	2933.21	....	350.12	....	398.62	....	846.74	331.80	996.64	393.08	25360.25
Ternitz.....	33303.02	10201.46	3531.31	275.98	157.01	65.79	828.26	149.03	1679.70	793.97	1873.62	1207.51	54367.56
Fischau.....	2779.88	24991.63	163.77	57.23	....	859.92	266.43	128.64	645.83	313.30	....	891.50	31098.13
Matzendorf..	....	1085.71	....	....	....	....	....	....	....	....	....	....	1085.71
Leobersdorf.	25405.89	8766.70	...	176.44	....	633.95	343.35	734.91	7079.64	327.05	330.60	4222.72	47921.25
Liesing.....	22519.26	1881.30	48.36	495.79	....	543.17	1218.66	1503.58	6906.88	3450.39	2936.94	3760.68	45420.05
Totals.....	107264.00	59918.42	12474.26	6439.05	852.24	2571.05	5832.31	2649.20	24031.38	9454.22	6952.01	12231.51	246825.59

Grand total 44,449 tons hydraulic lime.

Grand total 12,341 tons Portland cement.

rich white lime, which was, however, immediately removed by the municipal engineers, who would not allow any but eminently hydraulic limes on the work, and notwithstanding the explanation given, they insisted on the stable being constructed with best hydraulic lime mortar. Although such ridiculous mistakes occurred more than once, and a great deal of time was cut to waste in experiments, the principle of separate payments is a sound one, and cannot be sufficiently recommended to hydraulic engineers.

In order not to load this paper with figures I annex Table II., which shows the quantities of cement and lime used. Some of the Portland cement was supplied from England, in consequence of the Austrian manufacturers being unable to supply the immense quantities required in the years 1872 and 1873. The principal home manufacturers were those of Saulluh and Escher, at Kufstein, and Egger at Trieste; all these are natural cements, and the first-mentioned can certainly compete successfully even with the Burham Portland, or that of Messrs. Cranbourne and Lucas. Curtis' works, near Vienna, supplied a most excellent light, but eminently hydraulic lime, weighing 56 lbs. to 58 lbs. per cubic foot, but setting with extraordinary rapidity, even in running water, and therefore very useful in the execution of many of the works described. Of course this lime presents neither the same cohesion nor the same resistance to pressure as a cement, and does not harden much after the first month; but it is much to be recommended in contending with water, in cofferdams, lining tunnels, etc.

The municipality of Vienna kept a very careful account of all the experiments made, which would, however, be too long to give here even in abstract. They prove that the Austrians have made great progess in the manufacture of limes and cements, and are able to compete with foreign firms both as regards price and quality. With the assistance of these materials we were able to make the canal tight even in places where the pressure of the water was so great as to force the mortar out of the joints, and send it in jets against the opposite wall. It is owing to these also that the expense of repairs, which is generally estimated at about 5 per cent. during the first three years in similar works, has hardly attained a tenth part of that sum. The waste of water which we have seen reached 48 per cent. in Ancient Rome, is not commensurable here. Gaugings, which have been taken near the springs, prove that the same quantity of water, which there enters the conduit, reaches the distributing reservoir at Rosenhugel without any contamination or increase of temperature, and this indubitable fact appears the best answer to the many hostile critics who have attacked the Vienna Water Works from the very beginning to the end. "The proof of the pudding is in the eating," and the execution of the aqueduct having been perfectly successful, the supply of water being pure and plentiful, criticism on the mode of construction and the design appears useless.

In Table III. I have annexed a schedule of the prices paid the contractor for the different descriptions of work, reduced to English measurements and money. The prices of masonry are exclusive of lime or cement, but include all centering, scaffolding, temporary roads, bridges, etc. I have not touched upon the second position of the work, namely, the mains and the distribution. This would have made the papers far too lengthy, nor does this portion of the work present so many features of interest, since mains and pipes are laid, with slight differences of detail, on much the same principle everywhere.

In conclusion I may mention that the introduction of the fine spring water from the Alps by means of the works described, has had a most beneficial effect on the mortality of Vienna, which in 1873 had attained the enormous figure of 35 per 1000. Notwithstanding the slackness of trade and business which has continued since then, causing an unusual amount of distress and pauperism, notwithstanding two unusually severe winters, and a summer (that of 1875) in which fruit was so plentiful that pigs were fed on peaches, a fact nearly always causing choleraic diarrhœa and dysentery, the rate of mortality has steadily decreased ever since the 1st of January, 1874, and is continuing to decrease almost in proportion to the introduction of water supply to the houses. The figure for 1874 was 28, that for 1875 is not yet exactly fixed, but approximates to 25.5. So satisfactory a result induces us to hope that the example of Vienna will soon be followed by other towns of the empire, and that they also will hasten to supply their population with the blessings of a plentiful supply of pure water.

THE present number completes the foregoing excellent article on Water Works. We have given all the illustrations but two or three which were unimportant and which we could not reproduce except at great expense. We here also beg leave to acknowledge our indebtedness for the entire article to *Engineering*, in the columns of which it appeared in print for the first time, and which gives all the illustrations. As we cannot supply the back numbers containing the article, parties who desire to possess it can obtain it only through Messrs. Miller & Smith, New York city, American agents for *Engineering*.

The Jetties at South Pass.

We learn that for some time past the channel between the jetties, at the mouth of South Pass, is everywhere more than two hundred feet wide for a depth of twenty feet, at average flood-tide, and that in the middle of this wide channel the depth is more than twenty-two feet. This is equal to from 22½ to 23 feet at the highest tide at South Pass, when a range of three feet tide, with a channel depth of 19½ feet for from 80 o 100 feet in width, is usually reported at Southwest Pass. Therefore it is seen that the jetties have given, although yet in an incomplete state, a magnificent channel across the South Pass bar to sea, twice as wide and several feet deeper than has ever been obtained across the Southwest Pass bar. If this is considered as any indication of a failure of the jetty system, then we should welcome all such failures; they are what we should pray for earnestly. All through South Pass, from its head to the jettied channel over the bar, as is generally known, the depth exceeds thirty feet for more than two hundred feet in width.

We are informed that the works required to confine the flow of water from the main river, above the common head of the passes, into South Pass, so as to secure a like deep channel entrance to South Pass over the river middle-ground shoal above its head, are being energetically prosecuted, with every prospect of early success. Already, notwithstanding the low stageof the river, the one-dipper dredgeboat at work there to expedite the cutting out of a deep channel entrance, has succeeded, as we are assured, in obtaining a depth of inlet of from twenty to twenty-two feet across the shoal, which the tidal current suffices to maintain and widen. Soon, we are told, two more powerful dredges will be put to work there, and, with three boats working together, an entrance channel across this hard sand middle-ground shoal, of sufficient width and depth for the largest class of ocean steamers, even at the present low river stage, may be expected at an early date. With the river at the height it was three months ago, we would have even now a clear and unobstructed channel of more than twenty-two feet in depth, from New Orleans to the sea, through South Pass.

This long looked and hoped for desideratum, "an open river mouth," seems at last to be near of accomplishment, and we take pleasure in congratulating the merchants of our city on the prospect of the revival of their business interests which must result therefrom.—*N. O. Picayune, Nov. 3.*

A GOOD ENGINEERING PAPER—HOW TO MAKE IT.

With the approach of cold weather the season of engineering field operations is drawing to a close. New works are seldom inaugurated in the Northern states at this time of the year, and only such portions of old works are prosecuted as are not affected by frost. Engineers are soon to be busied in the office, revising designs, drawing more careful plans than the busy time of summer would allow, copying field notes, and making calculations and projects for a new season. It will be perhaps a time of comparative leisure, and we therefore seize an early opportunity to renew some suggestions, as to what a good engineering paper ought to be, and how it may be made a satisfactory one.

An engineer upon any class of work will prize his paper more highly, if he can find in its pages, from time to time, accounts of the progress of similar works, details of the construction, facts and figures, accompanied by more or less illustration, a clear statement of difficulties surmounted and the way in which they were overcome, and, lastly, if one can be persuaded to tell of them, the expedients, proportions, etc., which have miscarried and failed. It is by this latter class of examples of engineering practice, or perhaps we had better say, by these instances of engineering failure, that we are well instructed for future emergencies. A structure which stands and fulfils the purpose for which it was built may, at the same time, not be economical, by reason of an extravagant use of material, or otherwise; but one which has failed has, to the careful examiner, developed its weak point, and enabled him to test critically the theory upon which it was designed Instructed in that direction, we shall no longer follow precedent and copy previous examples, but shall improve and better adapt our construction to the required end.

As many of us are not confined closely to specialties, and as those who are so confined also feel an interest and a sympathy in the progress of the whole profession, the line of articles to which we refer above will be welcome to all of our readers.

A good engineering paper should also give all of the news of the profession, as of general interest, besides being valuable to those who are on the lookout for new business connections. How well we have done in this direction in the past, our columns for the last nine months will show. The paper should also be a good medium between engineers and those with whom they have business dealings; such we have endeavored to make it.

As we have said before, it has been a shame that American engineers have been obliged to seek foreign periodicals for descriptions of American engineering works. So far as has been in our power, although not to the extent which we have wished, nor to the extent to which we propose to go in the future, we have removed this reproach.

Now to exhort:—While we have been earnest in the endeavor to collect all matters of interest, we have failed to obtain many things which would be of value, because we were not on the spot, and so did not hear of what was done at the time. We therefore call on all who desire to see in our columns, the latest items, the correct information in regard to undertakings, the statements and descriptions of completed works, to send us all facts which are of their personal knowledge, be they in the shape of dates and figures, clippings from local papers, or articles of some length. We have to thank heartily those who have already favored us in the past, and, unsatisfied, to ask for more. We know that the past season has not been a busy one, and that some of our brethren have not had all the work to do which they desired; but there has been considerable activity in some quarters, with a more encouraging outlook for the future. To those who have been actively engaged we would address ourselves, when we ask that we may be favored, during the winter, when they may find leisure time, with such accounts, more or less in detail, of what they have done the past season, as they think will interest engineers, architects and contractors.

A word on another point will not be amiss. Kind reader, you who value highly the facts and views which you find in our pages, who look for the paper each week with interest, and read it with pleasure,—but whose name is not on our subscription list,—we shall be pleased to put it there upon the receipt of the right word from you. We have many warm admirers, if we may believe all that we hear; but it costs a great deal of money to bring out these sheets, and an endorsement which is not backed up by anything substantial, a cheerful interest as shown only by the ready reading of another's paper will not pay the printer. We desire to illustrate more abundantly than we have as yet done, and to increase the size of our paper as soon as circumstances will warrant. Whether they already get their money's worth, our subscribers can judge for themselves. We shall take no step backward. We only ask for the earnest support of our professional brethren, both by their pens and their pocketbooks.

BENEFITS OF ADVERTISING.

For nearly two years we have had on our shelves a number of copies of the incomplete Vol. I, of ENGINEERING NEWS. Being fragmentary they were slow of sale at fifty cents while the complete volumes, containing but three more numbers than the other, were all sold out long ago at two dollars. By means of two weeks' advertising we have disposed of *every copy* and still the orders are coming in. We feel assured that every person who bought the incomplete volume feels that it is worth all that he paid for it, and in this fact lies the secret of successful advertising—*having announced an article for sale be sure that the purchaser gets good value for his money.* Acting on this motto we offer to our readers VOLUME TWO, of ENGINEERING NEWS. It is complete; it contains 156 pages of reading matter besides several illustrations and numerous diagrams; it is bound in paper covers, and includes a carefully prepared index of subjects; it is well printed on most excellent paper, and its contents are of interest and value alike to the Civil Engineer and the Land Surveyor. It is an improvement on Volume One, which was sold at two dollars; but the price was put down to the nominal rate of One Dollar for the purpose of securing its more rapid introduction among the profession. It is therefore now offered in book form at One Dollar in order to ensure the rapid sale of the copies remaining on our shelves, and of which we do not expect to have one left by the end of the ensuing month.

As all our readers are aware, these volumes are composed largely of most practical and valuable engineering papers selected from the Proceedings of various societies in this country and in England, and which cannot be obtained from any other source, except by becoming members of these societies. Many of these papers are, singly, worth the price that is asked for the volume, and we are sure that it is an opportunity that will not be offered very soon again for obtaining so much for so little money. Experience has shown that books of this character become greatly enhanced in price as soon as they are out of print, and we will leave our readers to judge for themselves after they have seen the class of subjects of which it treats, whether our Volume Two does not bid fair to be classed among the number. We are already disposing of the volumes each week and we are certain that as soon as it is known that the numbers of last year are bound up in neat, book form, and offered at the regular subscription price, that the entire edition will soon be disposed of.

The Origin and History of the Progress of Engineering Thought.

Abstract of a lecture delivered by Wm. J. McAlpine, Civil Engineer, M. I. C. E. of London, Past Prest. of the S. C. E. of the U. S., etc.,—on the 19th of October, 1876, at a joint meeting of the members of the Societies of Mining and Civil Engineers at Philadelphia. Prepared by the Author for ENGINEERING NEWS.

The lecturer explained, that a few years ago he had been called upon to deliver one of a series of scientific lectures of which his topic then was on "Modern Engineering," in which he had compared the works of the ancients, with those of modern times.

The studies connected with the preparation of this lecture had strongly directed his attention to the remarkable coincidences in the history of all nations and societies in regard to the mechanic arts; begining with rudeness, continued with improving culture, to a culmination, and then by gradual decline, to ultimate decay, yet that there was upon the whole, a continued advancement of knowledge in the world up to the present time.

These reflections led the speaker to the consideration of the subject of the present paper in which he proposed to consider it during four great periods of time; viz. *First.* Previous to the times of what we have been accustomed to term, those of reliable profane history;

Second. Extended down to the dark ages of European civilization;

Third. To the close of the eighteenth century; and

Fourth, to and of the present time.

This, the first of a series of four lectures, embraces the first division above stated.

The speaker then called attention to the physical condition of a human being placed among the other animals to some of whom he was inferior in strength, fleetness or endurance; a habitat of one element while birds and some of the beasts were of two; yet in despite of these inferiorities, man soon became the ruler of the whole animal kingdom, and, eventually, the director of many of the operations of nature. He has forced the winds, waters and earth, the gasses, liquids and solids under his subjection.

The mind is offended by the rude traditionary fables of the earliest of profane histories, and to arrive at a true history of man's thoughts before, and even at that period, the lecturer proposed to consider, *first*, a man placed among the other animals and the elements and to trace him step by step from that rude condition of life, to the time when we consider his actions by the light of authentic history.

Next, to confirm this inductive process by comparing its results with those of the existing societies of men, from the dirt-eating Indians of this continent, or those of the semi-brutes of the interior of Africa, step by step through the savage nations as they are now found in many parts of the world,—and those who are more and more advanced in civilization, and continued through the existing semi-civilized nations, and up to the highest degree of civilization, and, *finally*, to consider the most authentic of the ancient histories which apply to the subject, and after correcting the exaggerations and errors, wherever it is possible, and rejecting from consideration those which are palpably false.

History, thus corrected, becomes reliable as no other history, and the same method may be applied to later, and even to modern history, to great advantage.

In illustration of these formulæ the speaker stated that the primeval man at first demanded food, then clothing and then habitations; his food at first limited to fruits and the natural products of the soil soon after required the exercise of mechanic arts to break up the earth, and a *spade* was his first invention.

The domestication of the most mild of the animals led to the application of their powers to the plough, to back borne burthens and to the haulage of rude carts, in each case calling forth man's inventions of the agricultural implements, the roadways and the carriages, all of the rudest description,

Meanwhile man armed himself with sharpened poles or javelins, then pointed them with bones or sharp stones, and at a much later day, with the hammered-out metals; but probably during this period invented the elastic bow and javelin-shaped arrow.

To overcome the fleetness of some of the animals, man commenced association.

The clothing of man, first of the skins from the sacrificial animals, was soon changed to those knitted of their wool or fur, or the soft fibres of plants or trees.

After the domestication of the cow, ass, horse, camel, sheep, etc., the rude pathways which had sufficed for the path of the footman had now to be improved for the passage of the mounted man, and when carriages were introduced these pathways had to be improved into roadways. Morasses were crossed by unyielding dykes, water courses were spanned and roads were located on appropriate grades.

On the water man began his transportation by a log, next it was hollowed out into a canoe, heavier weights were water borne on rafts and then on two or more canoes, and finally on water tight vessels.

Water courses were crossed at fords, which were shallowed by large stones, then crossed by the trunks of long trees resting on the opposite shores, then by piers, or suspension bridges of vines and next of ropes were introduced.

As society advanced new demands for human invention arose, as fabrics made by spinning, then by weaving, which led to the highest advancements in this line of mechanic art.

The easily worked metals soon came into use and

with them the labors of the mechanic were advanced.

The clay and slime along the banks of a river, hardened by the heat of a tropical sun, suggested bricks and tiles, which soon after were hardened by fire.

Stones were quarried and rubbed smooth by harder stones.

The forest buildings were first made by cutting off contiguous trees, by placing thereon longitudinal tree trunks, by roofs of tree limbs, and thatching and a top covering of leaves and turf. These rude habitations contained all of the elements of a classic edifice, and when trailing plants grew on the earthy roofs and surrounded the entablatures and heads of the columns, the first idea of ornamentation was given to the architect.

The lecturer then showed that in the Bible these inventions of man succeeded each other in the same order and then that the profane history of every nation again confirmed this regular succession of the development of mechanical art.

After this the lecturer took up many of the recorded early engineering works, those attributed to Semerimus, Moeris, the pre-historic monuments of India, Assyria and Egypt, and showed which were fabulous, which were gross, and which were venial exaggerations; and then stated that his second lecture was nearly complete for delivery, and would be followed by the others, and when the series was complete the whole would be published together.

We are again obliged to postpone "Sanitary Engineering," on account of the delay occasioned in preparing the "Tables" referred to in a previous issue.

At the weekly Conversazione at the rooms of the Am. Inst. of Mining Engineers in Philadelphia, on Oct. 26, Mr. Thos. Lintwell of England, spoke for almost twenty minutes upon the effect of open *versus* closed furnace tops upon the yield of the furnace, and illustrated his interesting remarks by copious sketches on the blackboard. There was a large attendance of members and visitors at the rooms.

It will doubtless be of interest to readers of the News to know that Mr. Edwin A. Barber, of West Chester, Pa., who had charge in the Centennial Exhibition of the exhibits of the Geological Surveys, and who was with Prof. Hayden in Colorado and Arizona for two years, has three lectures ready for delivery on the (1) Ancient Pueblos or ruined cities of Utah and Arizona, (2) The Moqui Pueblos, and (3) Modern Indian Tribes of the United States. Literary Societies and other institutions throughout the country cannot do better than increase their acquaintance with the wonderful archæology of the "far west," by means of these lectures illustrated as they are by photographs, drawings, and the Stereopticon.

We are permitted to take the following extract from a recent letter of Charles Sooy Smith from London, England:

"In the evening we saw a man dressed in one of the recently invented fire-proof suits, walk into an immense fire and remain several minutes. The heat was increased by having oil poured on the fire, so that he was frequently wrapt in flames. The suit is similar to that of the submarine divers, with, I suppose, a lining inside of which air is pumped through a pipe which passes through another pipe conveying cold water between the lining and the exterior. The latter is of some porous material (probably asbestos cloth) through which the water constantly percolates. He also carries in his hand a nozzle by which he can direct a stream of cold water on any part of himself which is in danger of being injured by the heat. He seemed to be able to remain in intense heat indefinitely and could carry red-hot timbers with the greatest *coolness*."

The Canadian Minerals at the Centennial Exhibition.

(From a Correspondent.)

The "Mineral Department" forms the most prominent single feature among the Canadian exhibits at the Centennial. It occupies a large space on the north side of the Main Building. At the east end of this space is a row of columns of coal showing the thickness of the principal seams of the Nova Scotia and Cape Breton collieries, while at the west end the coals of the North West Territories and British Columbia are represented.

The iron ores comprising magnetite, hematite, ilmenite, limonite, and spathic ores are represented in most cases by large blocks from upwards of fifty different localities.

Copper ores and native copper are shown from about twenty localities. Copper has been successfully mined in several parts of Canada. The Bruce and Wellington mines on Lake Huron, belonging to the West Canada Company, have been worked for thirty years and have produced $3,300,000 worth of copper. The Hartford mine in the province of Quebec has yielded upwards of one million dollars worth of ore.

Among the lead mines, there are some fine specimens of galena from the Frontenac mine, near Kingston, and from veins occurring near Lakes Huron and Superior.

Zinc, antimony, bismuth and platinum are all represented by specimens more or less rich.

There is a fine display of ores from the silver mines of Lake Superior, of which those from Silver Islet are the most conspicuous, having an intrinsic value of $1,450. The specimens of ore and ingots of silver from British Columbia show that that province is rich in this metal as well as in gold.

The total yield of gold in British Columbia, since the first discovery in 1858, amounting to $38,166,970 is represented by a fine gilded pyramid, which has a very striking effect. There are also samples of gold from about twenty different localities in British Columbia from the Saskatchewan River, from the Lake Superior and the Hastings regions in Ontario, from the Chaudiere region in Quebec and from various mines in Nova Scotia.

Canadian petroleum and its products are well illustrated by a fine series of specimens and preparations by Messrs. Waterman Bros., the well known refiners of London, Ontario. The collection also contains samples of the petroleum of the North West Territories and the Gaspe peninsula. Besides coal and petroleum, lignite, Albertite, oil-shales and peat may be mentioned among the mineral combustibles afforded by the Dominion, and which are here represented by specimens from various localities between the Rocky Mountains and the Atlantic coast.

The minerals applicable to chemical manufacturers comprise iron-pyrites, phosphate of lime, magnesite, chronic iron and oxide of manganese, of all of which there are large and fine specimens.

Mineral paints, such as iron ochres (raw and prepared) barytes, celestine, etc., are shown in great variety.

Salt and brine are exhibited, not only from the great salt region of Ontario, but also from the North West Territories, New Brunswick and Nova Scotia—in all, some fifteen different localities.

Of materials applicable to decorative construction, the show of marbles, embracing large polished slabs from about forty-five localities, excites both admiration and surprise. There are also beautiful red granite from the Hon. John Young's quarry at Kingston, Mr. Forsyth's at Gananoque, and from the quarries near St George in New Brunswick.

The principal building stones of the Dominion, upwards of twenty in number, are represented by a uniform series of cubes of six inches, polished on one face and dressed in various styles on the others.

The slates of the provinces of Quebec are unsurpassed by any in the world. The are here represented by large planed and polished slabs, blue-black, red, and green roofing slates and school slates of all sizes.

There is a good series of specimens of such materials as flagstones, gypsum, lime, hydraulic cement, drain tiles, bricks, clays, moulding sand and materials for glass-making.

Of refractory materials, there is a splendid display of crude and prepared plumbago from several of the mines on the north side of the Ottawa. Numerous specimens are also exhibited of soapstones, potstone, mica and mica-rock, asbestos, fire-clay, and refractory sandstones.

The materials for grinding and polishing include a variety of grindstones, millstones, whetstones, hones, tripoli, etc.

The specimens of minerals applicable to the fine arts and jewelry constitute perhaps the prettiest feature in the collection. Among them are prepared specimens of lithographic stones, porphyries, labradorite, albite, perthite, agates, jasper-conglomerate, and amethystine quartz. The jasper-conglomerate is a very remarkable and beautiful rock, consisting of black and blood-red jaspers, thickly disseminated in a matrix of white quartzite. It occurs in massive beds on Lakes Superior and Huron. The amethystine quartz, of which some great masses of huge crystals are shown, comes from veins at Thunder Bay. The lithographic stones are from two localities, one discovered by Professor Bell near Walkerton and the other, which has long been known, in the township of Marmora.

In addition to this fine series of economic minerals, there is a stratagraphical collection of upwards of 1,000 nicely dressed specimens illustrative of the rocks of all the formations of the Dominion. Several fine geological maps and numerous photographs are also displayed in the Canadian mineral department.

All things considered the above collection is probably the most *complete* mineral exhibit at the Centennial, although in some particulars, such as large size of certain specimens, it is exceeded by the United States exhibition. It does infinite credit to Canada and will no doubt be the means, sooner or later, of attracting capital for the development of her mineral resources. It has already had the effect of bringing orders for several of the mineral products represented.

This fine collection was made almost entirely by the officers of the Geological Survey of Canada in addition to performing their ordinary duties in the field during the season of 1875. The same gentlemen also prepared and had ready at the opening of the exhibition a complete "Descriptive Catalogue of the Economic Minerals of Canada," which is universally considered to be the most perfect work of the kind published in connection with the Centennial.

The Director of the Geological Survey has very wisely decided to present a large part of the above collection to the Smithsonian Institute in exchange for other specimens for the Museum of the Survey, and for the non-sectarian universities of the Dominion.

Philadelphia, *November 1, 1876.*

American Institute of Mining Engineers.

OCTOBER SESSION.

(*Third Meeting, Concluded.*)

(Special Correspondence of Engineering News.)

This was followed by an extempore description of "A proposed college for Mining and Civil Engineering in Tokio, Japan," by Prof. H. S. Munroe, and the curriculum intended to be followed therein. The course proposed was very thorough, practical and eminently suited to the requirements of the country, but all discussion was prohibited by the Secretary, on account of the shortness of time available for the Session. To give an idea of the importance of the mining industry in Japan, the following statement is given showing the production of the various economic minerals for the year 1874 in American weights, measures and values, (Ton of 2,000 lbs., gallon of 231 cu. in., and gold dollar):

Gold 827.2 lbs.	Value, $	245,000
Silver 21,428 lbs.	"	382,200
Copper 3,360 tons	"	882,000
Iron 5,600 tons	"	147,000
Lead 207.2 tons	"	20,850
Tin 8.4 tons	"	2,940
Coal 436,800 tons	"	1,911,000
Coal Oil 276,240 galls.	"	22,540
Total values,		$ 3,613,530

Mr. H. M. Howe then read an interesting paper upon the "Influence of increase of height upon the working and temperature of different zones in the blast furnace;" but as he spoke indistinctly, it was impossible to follow his statements closely. The tables upon the blackboard showed in full detail, the results of increasing the heights of two furnaces, the one to 80 ft., and the other to 48 ft.; one result being to raise the temperature in the uppermost or "zone preparation" as much as 90 per cent., thereby increasing the production.

The discussion which followed consisted chiefly of a lengthy talk by Mr. Thos. Whitwell of England, who described the six new furnaces erected at Consett, the results of altering their heights from 55 feet to 75 feet in increasiug the yield of grey iron and lowering the temperature at the throat to 473° Far. etc., etc. He then described the furnaces at Seraing which work on ore with 53 per cent. metallic iron, blast at 1400° Far., and the iron runs direct from the 60 feet furnace into the Bessemer Converter,—the first furnace to adopt this plan. He closed with statements to the effect that in-

creased height does not always give increased make; for instance, the furnaces at Acton, formerly 93 ft. high, were increased to 105 feet, but the most recent furnaces were not built over 95 feet in height.

The Report of the Centennial Committee was then read which dealt (1) with the reception of foreign guests, (2) the weekly Conversazioni and (3) the collection of books, catalogues, etc., for the Institute. There were 377 guests registered on the books from various parts of the United States, and 111 from 15 foreign countries, and of all these over 400 were mining engineers. Letters of introduction to the number of 494 had been given out to foreigners, and 41 routes of travel made out. There were 432 letters copied and registered in the books. The German Government has presented the whole of their interesting lead and salt collection to the Institute, the Spiegeleisen exhibit was also present together with Borsig's whole exhibit, and that of the Luzembourg and Saarbruck district. The handsome Fagersta exhibit from Sweden was also presented, Cooper, Hewitt & Co's. exhibit of iron and steel, and several others. The adoption of the Report was preceded by an animated discussion, in which strong grounds were taken against accepting any such donations as tending to localize the Institute to the place at which such collections should be deposited, and also the extra expense incurred by the maintenance of the same was strongly deprecated. In answer to these objections it was stated that at the close of the Exhibition, these donations would be collected together in the Memorial Hall by kind permission of the Penn. Museum and School of Industrial Art, entirely free of expense to the Institute, and subject at any time to immediate removal by the Institute. The meeting was then adjourned to 2.30 p. m.

On resuming, a description of a "Magnetic Carbon Indicator" was read by Chas. M. Ryder in which a piece of steel of known carbon percentage, placed at one side of a vertical needle and of course deflecting the same, was compared with another piece of equal size placed on the other side at such a distance as to bring the needle back to a vertical position, and such distance determined (by scale graduations) the amount of carbon contained in the same. A very neat little instrument, but with no provision for discriminating between the effect of carbon and the effect of *flaws*, upon the relative magneticity of the piece of steel under investigation. A short discussion by A. L. Holley and S. J Metcalf ensued.

The next business was the election of new members, associates and honorary members, of which a considerable list was read, and voted in by ballot.

The Secretary, Dr. Thos. M. Drown, then read a paper by C. M. Williams on the "Preparation of Zinc Oxide." For this purpose Wetherell's compound reducing and oxidizing furnace was used; of the results gained at the Lehigh Works and at the New Jersey Works 9 analyses were given. Charcoal is not used in the reduction as it impairs the color of the oxide. The size of the hearth is 6 ft. by 4½ ft., with 27 in. height above the grate bars. The ore assays were 64 per cent. zinc oxide with 24 per cent. carbonic acid. Analyses of zinc oxides and of the residues of the workings were then given. The discussion was limited to an expression of gratification by Prof. Raymond that members who could not be present in person like Mr. Williams should write such interesting papers as the one just read and on subjects so seldom discussed.

The two following papers were read by title only as the authors had been unable to propose them in time for the session, "Lignite Coals of Colorado," by Prof. W. B. Potter of St. Louis, and "Mineral Industry of Russia," by Prof. R. W. Raymond.

Dr. Raymond then made a few remarks on the Bessemer process in America. At its initiation its father, Mr. A. L. Holley, wagered that he could produce 1500 tons per month from two 5-ton converters; he more than succeeded by producing 1686 tons. This same amount, 1686 tons, had just been produced by two 5-ton converters in one week ending October 14th, at the North Chicago Rolling Mills; in one day of 23.40 hours the maximum of 73 heats were made yielding 391.5 tons of ingots. These figures are the highest yet reached. He next spoke regarding petroleum in California; that at first the discovery and workings were very disappointing in their results; the difficulty was in manufacturing a good oil out of the raw material they obtained. The district, San Francisco, is about 50 sq. miles in area, of oil-bearing shale which dips 32° in a southwest direction between wall rocks of sandstone. True petroleum has 40° gravity, and 130° fire heat, is white and odorless None of the wells carry paraffine. The completion of a railroad line for 40 miles, which reaches the Pacific Ocean, will help the industry, but there is no assurance of its ever becoming a large one.

The Institute then adjourned to next February.

C. J. MOORE.

On the Currents in Navigable Rivers.

BY A. RULLIER.

(Revue Maritime et Coloniale, vol. 1, p. 447, 38 woodcuts.)

Translated by the Institution of Civil Engineers.

Rivers in their flow tend to wash the materials of their banks into the bed of the stream. When the current is gentle, the silt and clay in the banks are deposited in the centre, and the sandy portions at the sides; the bed of the river is gradually raised, and the width increased. When the current is rapid the banks are undermined, the lighter particles are carried away, and the heavier portions remain at the sides impeding the undermining action, and the bed of the river is deepened: this action continues till the current slackens, when the banks again gradually resume their original slopes. The navigation of the strait reaches of a river presents no difficulty; the greatest depth is in general in the middle, and large vessels always follow the centre of the stream, but vessels of small draught when ascending the river hug one of the banks, as the force of the current is less at the sides than in the centre. When the river is shoal on one side the current is diverted towards the opposite bank which assumes a perpendicular face, indicating thereby the existence of a shoal on the farther side. When banks are formed in a river whose course is straight, they usually are found in the centre, of an oval shape in plan, and triangular in longitudinal section; their presence, when below water, is manifested by the deviation of the current and by the ripples they give rise to, behind which the water is smooth. Occasionally the channels on either side of the bank are equally suitable for navigation, but more frequenrly one channel deepens at the expense of the other, and this is indicated by the steepness of the banks of the deeper channel. When the river takes a bend the direction of the current does not at once follow the altered line of the banks, but approaches the concave bank, and brings the greatest velocity and the greatest depth of the river near that bank. The concave bank is gradually encroached upon, and a deposit is formed near the opposite bank, and the river frequently increases in breadth at the bend. On account of the direction the current takes at a bend, vessels ascending the river hug the convex bank, and, when descending, keep near the concave bank. If the bend is very sharp, the stream is directed with considerable impetus against the concave bank, and, washing away the bank and scouring the bed, strikes across the river towards the opposite bank; silting takes place at the convex bank, which becomes pointed and has a gentle slope, whilst the concave bank is vertical. When the course of the stream is a curve of small radius, the river has generally a small breadth in proportion to the amount of its discharge; the strength of the current merely approaches the concave bank, and banks are rarely formed in the bed of the stream. When the river curves gently and runs through a loose soil it increases in breadth, diminishes in depth, and banks are frequently formed in the middle.

Through narrow passes the depth of a river is usually considerable, and its flow rapid; in these places vessels are always obliged to keep the centre of the river so as to avoid the whirlpools and back currents caused by projections from the banks. A tributary flowing into a straight reach of a river leads to the formation of a bank, where the current of the tributary is checked by impinging upon the main stream, and, other conditions remaining the same, the size of the bank is proportional to the angle of inclination between the two streams. The best channel for vessels is generally on the side where the tributary flows in, except when the latter is very small. When the junction of the tributary occurs at a bend in the river on the concave side, the bed is scoured on that side, and a deposit is formed at the point where the bank and the tributary unite; the convex bank is little affected by the confluence of the two streams. If the mouth of the tributary is on the convex side of a bend in the main river, the tributary, finding little resistance at its mouth, on account of the sluggishness of the river round the convex bank, continues its course for some distance across the main stream till it gradually merges into it, turning the direction of the current, when the tributary is strong, still more against the concave bank and increasing the encroachment on that side. When the main stream takes a sharp bend and the tributary flows in on the concave side, the result is very similar to the case just considered. A tributary flowing in where the river is curving gently, and above the part where banks tend to form, renders the navigation very complicated, as a bar is formed which sometimes extends so as to unite with the banks in the river. The navigable channel is almost always situated close to the mouth of the tributary, gradually tending towards the centre of the river. When the junction occurs where the river is obstructed by banks, the waters of the tributary assist in opening a passage through the banks and improving the navigable channel.

The author explains at some length the proper measures to be adopted, in river navigation, in casting and weighing anchor, and the course that should be followed by a vessel going up or down a river in the various cases mentioned above.

L. V. H.

Drainage of Berlin.

BY M. MILLE.

(Annales des Ponts et Chaussees, vol. xii., p. 501, 1 pl.)

Translated by the Institution of Civil Engineers.

Berlin is a town of comparatively modern growth In the year 1686 it contained only twenty thousand inhabitants, and now its population is about one million. Situated on a plain of sand, on the banks of the Spree, it spreads over 15,400 acres, of which only 6,300 acres are covered with buildings. As regards drainage, Berlin has remained in a primitive state during the enormous growth of its population. A great part of the supply of water has been obtained from pumps which, situated at intervals along the streets, draw the water from the strata of sand; a portion only having been furnished by an English water company, which drew its supply from the Spree above the town. The roads badly paved and without proper footways, were bounded by ditches, as much as 2 feet 7 inches in depth, conveying the drainage of the streets and dwellings to the Spree, and crossed by flagstones or planks Herr Hobrecht was entrusted with the charge of designing and carrying out a complete system of drainage. It was determined to convey the drainage from the houses and roads through sewers, and to deposit it by irrigation on the land. By an order of the 14th of July, 1874, as soon as the sewer is completed along a street, it is incumbent on the householders to connect their tenements with it by a drain 6 inches in diameter, which serves to carry off the rain-water, slops and the discharge from the waterclosets; but no solid matter, cinders, or house refuse is allowed to pass down the drain. All cesspools are to be abolished, and waterclosets universally employed. The kitchen sink is provided with a grating, and a syphon and clack valve prevent the return of sewage gas through the house-drain; and the rainwater pipes are terminated by a syphon arrangement to arrest all solid debris washed off the roofs. Another order of the 4th of September, 1874, deals with the water supply, for the town authorities have purchased the waterworks, and an abundant supply is to be furnished to every house. The drainage and water supply are compulsory on the householders; and the annual amount required for paying off by degrees the capital expended on the works, together with interest and the cost of maintenance, is to be defrayed by rates levied on the householders. The drainage of the roads is to be effected at the same time; the gutters will discharge the water into earthenware pipe drains, 9 inches in diameter, laid along both sides of the road. They are connected with the secondary sewers, formed of stoneware pipes, 18 inches in diameter, or egg-shaped brick culverts, the width of which is two-thirds of the height. The secondary sewers lead into the egg-shaped main sewers, built of brick, 4 feet 4 inches wide, and 6 feet 7 inches high There are receptacles lor intercepting the solid matters from the streets, and ventilation is obtained through

man-holes connected with the main sewers. There being no fall, and the water level being near the surface, it is necessary to have separate sewers for the different districts. The population on each bank of the river is nearly equal; but Frederickstadt is most densely inhabited, and there the works are completed. The double-acting pumps will lift the liquid sewage 69 feet, and send it 8 miles in two iron pipes, 3 feet 3 inches and 2 feet 5½ inches in diameter respectively, to Marienfelder, where it is to irrigate 2,035 acres of land for the culture of vegetables, root crops and fodder, a plan already tried successfully at Thiergarten. On the left bank of the river there are two pipes, each 3 feet 3 inches in diameter, for conveying the sewage, after it has been raised 98 feet, to the estate of Falkenberg, 1,818 acres in extent, and 8 miles distant. Five 400-HP. engines are to be employed for dealing with the sewage, the quantity of which is estimated at 22,000,000 gallons a day. There are also two pumping stations, one on each side of the river, in the centre of the town, for raising the sewage of the low portions of the town and transmitting it to the pumping stations on the outskirts. The cost of the works is estimated at £1,600,000, of which £400,000 have already been expended on the drainage of Frederickstadt; and it is calculated that the work will be completed in ten years. L. V. H.

Opening of the North Sea Canal.

It may be interesting to the readers of the *Eagle*, who so lately were intent upon the achievements of General Newton, at Hell-Gate, to learn something of another great engineering exploit here in Holland, a country that literally owes its existence to science, the successful accomplishment of which was signalized November 1st in the proudest possible manner. This was the opening of the North Sea Canal to the traffic of the world by the King in the presence of all the Ministry and many of the diplomatic corps. The details of this ceremony will have reached you before now, so I will devote this letter to some description of the work, its history and cost, and the influence it is expected to exert upon the maritime commerce of Holland and other seafaring countries. The prescience of the First William, who more than half a century ago dissented from the plans which were submitted to him for constructing the North Holland Canal from Amsterdam to the Helder, the northernmost point of the province of North Holland, and over fifty miles from Amsterdam, has been surprisingly verified. William I, striking his pen boldly from East to West almost identically along the line taken by the new canal declared that this was the true course of the sea. But he was overruled by provincial interests, and it was left to time to demonstrate that if the great port of Amsterdam, which sprang into sudden importance when the Spaniards had ruined Antwerp would escape the danger of joining the melancholy sisterhood of the dead cities of the Zuyder Zee, some means must be devised for deepening the channels by which once the riches of the world were brought to her doors, but which had since grown too shallow to float the great vessels which carry the merchandise of modern days. Rotterdam has long been growing in importance at the expense of Amsterdam, and it remains to be seen whether the expectation of a return of prosperity to the latter will be realized. By a cut of fifteen miles Amsterdam has been brought within an hour or two of the German Ocean at ordinary tides. It is the old story of the Mountain and Mahomet. Amsterdam will not go to the sea, but the sea has been brought to Amsterdam, and it will be interesting to watch for the next few years what use these slowgoing Dutchmen, with their shrewdness for business and great accumulation of capital, will make of this advantage.

The first spadeful of earth for the new canal was turned over in March, 1865, and now, after eleven years of laborious effort, the great work, in some respects the most remarkable ever undertaken, approaches completion. It is considerably shorter and a trifle shallower than the famous Suez Canal, but is wider and contains engineering works in its dam at the east and its locks at the west, which the work of M. de Lesseps is entirely without. True, it has no busy town at its eastern end, as has the Suez Canal; but it is in anticipation to transform the desolate sandhills which now mark that termination into a vicinage of beauty and style in the establishment of a fashonable bathing place under the name of Ymude. This last, it should be explained, is Dutch for "the mouth of the Y," a shallow lake, so called, possibly, from its shape, which formerly extended from the Zuyder Zee to within three miles and a half of the west coast through a portion of the country called "Holland op zijn smalst." From Schellingwonde Locks to the sea the canal is sixteen miles long. These locks are to the east of the city, and the distance to the German Ocean by the canal from the principal quays is but fourteen and three quarter miles. The channel at its bed is eighty-eight feet six inches wide and at the surface 207 feet. At present the full depth has not been reached, but when this is completed the depth will be such that vessels drawing over twenty-three feet of water can pass throughout its entire length. It is intended ultimately that the canal shall have a depth between the North Sea lock and the sea of 8.50 meters below the Amsterdam pile, and from the North Sea lock to Amsterdam of 7.70 meters below the normal water level, with an average width at the bottom of thirty-five meters. The Amsterdam pile anciently represented the mean between high and low water mark. The tides are two or three inches lower now, but the measurement designated by the letters A. P., is still adhered to. There are ten lateral canals whose aggregate length equals that of the main canal; the length of banks in the whole set of work, including polders, is forty miles, and the extent of excavation equals 13,000,000 cubic yards.

The construction or formation of these "polders" has constituted one of the most interesting features of the work, and deserves description if for no other reason than in illustration of that remarkable system of reclamation of land which has alone, by its financial results, enabled this canal to be completed. This is the process: The sand excavated in one part of the canal is conveyed in barges and deposited on the clay covered bottom of the lake. Gradually the bank makes its appearance above the surface of the water, and as soon as this occurs it is formed, and the slopes are protected with fascines from the wash of the waves. The bank holds at first the relation of a dam or water tight bulkhead, forming a division between two masses of water—one a comparatively narrow channel, the other a broad expanse, but shallow. Upon the latter Archimedean screws are put in play, and the water is forced out into the canal adjoining. When this is accomplished the bed of the ancient lake becomes a meadow and is known in the vernacular as a "polder." Within a fraction of 12,500 acres, have been reclaimed in this manner, 8,500 acres of which have been disposed of at auction at an average of $400 gold per acre, though for agricultural purposes $600 have been paid, and in the vicinity of Amsterdam, portions valuable for building purposes have brought as high as $1,700 per acre in gold. By this reclamation and sale of land, which is by no means rare in Holland, the net cost of the North Sea Canal in cash will probably not greatly exceed $5,000,000, though its gross cost is set down at more than $10,000,000 The effect produced by these polders is certainly unique; and were it not for the system of stationary steam engines which has been instituted to keep the reclaimed lands dry by constantly pumping the water from them and pouring it into the canal, together with the organized precautions of the authorities, one might expect to find the sea reclaiming its own. Almost everywhere in Holland, while your barge floats above the chimneys of the houses, you may see below the towering banks of the canal's green meadows thick with cattle, each of the cows blanketed to protect them from the damp.

The canal was excavated by dredging almost entirely, three kinds of dredgers being used. The ordinary bucket dredgers discharging into mud barges were extensively used; but an excellent result was secured discharging the mud into a vertical cylinder, whence it was forced by a powerful pump through floating wooden tubes with leather joints, and so conveyed at once to the land. By a third arrangement water and sand are sucked up by a centrifugal pump. The trunk let down to the bottom is attached by a joint to the dredger, and by this means 1,200 to 1,500 tons of sand have been excavated by one dredger with a twenty horse power engine in a single working day. The auxiliary works are commensurate to the importance of the main project. Side canals run to all the fishing villages and tolls are only to be charged at the western end of the canal, so that the local traffic will continue to be free, and will reap the advantage of a deepened channel. At Velsem and Zaandam there are draw bridges, the latter a railway bridge, and where the side canals enter the main canal there are also bridges for the purpose of the towing paths, which are continuous on each side. To correct the tendency of the loose banks to be washed away by the swell created by steamers, they are lined with broken brick, fascines and clay. Thirteen hundred yards before the sea is reached are the North Sea Locks, before referred to. These locks are unusually high and strong and provided with extra gates to be used when the tide is more than 1.50 metres above the Amsterdam pile, and when it reaches 1.75 metres, which is the forbidden height, the gates are not permitted to be opened at all. There are two locks and a sluice. The sill of the larger lock is twenty-eight feet eight inches below ordinary low water, and it will admit a vessel 393½ feet long and fifty-nine feet wide. A short tidal passage outside the locks leads to the harbor, which is being built of concrete blocks made in the vicinity of Portland, cement, sand and gravel brought from the Rhine. These blocks weigh from six to ten tons each. Two moles, which start at the sandhills, 1,313 yards apart, extend each 1,600 yards into the sea and converge, so that the entrance is 284 yards wide. An elliptic space enclosed by them is being dredged to twenty-six feet three inches below low water. About 135 acres are to be dredged at first. The sandy bottom on which they are founded is first covered with a layer of basalt rock brought from the Rhine, about forty yards wide and about one yard thick. This stratum was kept 200 or 300 yards in advance of the pier in construction, so as to be well imbedded in the sand and settled in its proper place before the foundations of the pier were laid. The basalt rubble is leveled by divers, and the concrete blocks are set upon it by an immense traveling crane or Titan, running on rails on the completed portion of the pier. The mole is thus in general built up to 13 feet 6 inches above the Amsterdam pile. The piers are 27 feet wide at the top, and increase in thickness downward by one-seventh of their height. There are two lighthouses on land, beside the pier head lights. The two piers are each but 60 yards less than a mile long, and the construction of each requires 433,600 yards of blocks, 77,700 tons of cement, 299,000 cubic yards of shingle, 130,900 cubic yards of basalt, 9,035 of ballast, 34,611 of broken bricks. Further to secure the moles against the billows a slope of rock is thrown into the sea on the outside of each pier. The lower blocks of these wave breakers are 10 tons each in weight and those above low water weigh about 20 tons.—*Correspondence Brooklyn Eagle.*

Correspondence.

Mr. Editor:—Many thanks for your article on "Surveying Legislation," (ENG. NEWS Nov. 11th).

In your "Technical Education" (July 29th) you seem to admit that some sort of legislation may be necessary. We motion a vote of thanks to Mr. Le Baron for his "Reform in Engineering Practice" (Aug. 26th). We wish the scathing remarks in which he indulges might reach every man in our land. He seems to be decidedly of the opinion that legislation *is* necessary. How would an act similar to the one proposed in ENG. NEWS Jan. 22d, answer? The best point we know of in favor of the County Surveyor's office is, that he must answer all calls promptly, either in person, or by deputy. We are perfectly willing that said office be abolished; but we deem it *very important* that the field notes of each survey be kept at the county seat—perhaps with the Register of Deeds—and be accessible to any one desiring to examine them. B. F. D.

FULTON, Mo., *Nov.* 21, 1876.

Editor ENGINEERING NEWS:—To what extent is a Co-Surveyor to be governed by the acts of his predecessor in office? Nearly nine-tenths of the work in this county has been random work; the centre corners established by running half through the sections instead of twice through; the fallings or "jogs" on the Township and Range lines sometimes double, and sometimes half the distance given in the field notes, and frequeutly in the opposite direction. To change the work makes great trouble for the farmers; to let it remain gives one party often ten or twelve acres more than his deed or patent calls for, and of course another that much less, and establishes a wrong base on which all other corners

in sometimes four sections must be governed. Can a wrong survey, by a county surveyor, invalidate a man's title to what the government deeded him? I have had three of the best surveyors in the State to test the old work, and it has proven unreasonably erroneous every time. Please answer as soon as convenient. H.

IT is a difficult matter to decide what to do in cases where numerous contiguous inaccurate surveys have been made, and which have for a long time been concurred in by adjoining owners of land. There are so many local circumstances to govern each case that only a careful, conscientious, and capable surveyor, *on the ground*, can decide, and then his decision must be made up after a pretty extensive survey of the whole region. A principle of expediency must usually be adopted, but adjoining owners must be obliged to agree to surveys made in accordance therewith, otherwise we would adopt a rule to get exact corners where possible, and make the surveys in strict accordance with the instructions and government notes, and leave the further decision in the hands of the lawyers and courts.

NOTES.

Two hundred thousand dollars worth of new buildings are now going up in Atlanta.

Gold veins of Lumpkin county, Ga. are becoming richer as work upon them progresses.

Miller & Jamison, Bridge and Car Works, Cleveland, O., are working 60 men on boiler bridge work,

The life-saving stations on the coasts of New Jersey and Long Island have rescued 3,168 persons in the last four years.

The favorite American systems of bridge building have been adopted by the Brazillian government for use in all future internal imports.

The sheriff of Butler county, Pa., has advertised for sale the main line, pump stations, telegraph lines, etc., of the Pennsylvania Transportation Company,

Zug & Co.'s new rail mill, Pittsburgh, was completed last week, but it will take about two weeks to get the new engine and battery of boilers into working order.

Six hundred tons of rock were recently displaced by a single blast at the quarries of Scholl & Bros., near the East Penn Junction, Schuylkill county, Pa. It will require from three to four weeks to remove the rock that has been loosened.

Mr. A. B. Stone, president of the Cleveland Rolling Mill Company, has been recently elected president of the Poughkeepsie. N. Y., Bridge Company; *vice* John F. Winslow resigned.

The *Bulletin of the American Iron and Steel Association* says: "The much-talked about petroleum pipe line from the oil regions of Pennsylvania to the seaboard is an exploded chimera. The scheme has entirely fallen through, and the principal projector has narrowly escaped going to jail.

A car propelled by compressed air has been used successfully for more than two months on a street railway near Paisley, in Englaud, under every condition of traffic and weather, performing a trip of three miles for each charge of air, at a cost of about one cent a mile. When the rails are not slippery with mud or ice, a considerable surplusage of air is left in the tanks.

Experiments are making at the Cambria Iron Works, Johnstown, to test the possibility of cokeing, as they do in Wales, the following mixture: Anthracite culm or slack, sixty per cent.; bituminous coal (Latrobe), thirty-two per cent.; pitch, five per cent. The test is being made in the Belgian ovens of the Cambria Iron Co.

A petition has been filed in the Circuit Court in Richmond asking the court to take the property of the James River and Kanawha canal company under its control and appoint a receiver therefor. The petitioners submit a series of charges impeaching the present management, who have brought the company to insolvency by burdening the treasury with reckless and large expenditures, failing to pay interest on both mortgage debts, and committing other serious breaches of trust.

The growth of iron manufacture in the west is well illustrated in the case of Chicago, which is situated remote not only from the iron mines, but also from coal suitable for the purpose. Of the ten Bessemer steel works in the United States two are located in Chicago; and of the 291,000 tons Bessemer steel rails made in the country last year, 85,000 tons, or nearly one-third of the entire amount, were made in Chicago. The iron industries have 200 establishments, employ 10,000 workmen, and manufacture to the amount of 35,000,000 annually,

In 1804 Oliver Evans constructed for the Board of Health, Philadelphia, a machine for cleaning docks, which is called the Orukter Amphibolos or Amphibious Digger. It consisted of a heavy flat-bottomed boat thirty feet long and twelve feet wide, with a chain of buckets to bring up the mud, and hooks to clear away the sticks, stones and other obstacles. It also had wheels for running on the land, and a stern wheel for propulsion when afloat. It was operated by a high-pressure engine, the cylinder of which was five inches diameter and nineteen inches stroke. The whole apparatus weighed 35,500 pound, and could be run by the engine up any slope of less than four degrees. This seems to have been the archetype of stern-wheel steamboats, dredging machines and steam carriages.

Yosemite has a rival. A valley has recently attracted attention on King's River, Fresno County, California, which is forty-five miles long from east to west, and averages half a mile wide at the bottom. The Fresno Republican says: "It lies 5,000 feet above the sea, and its walls, which are about 3,000 feet high, are very precipitous. In this valley a new grove of colossal redwood trees has been discovered. One of them eclipses all that has been discovered on the Pacific coast. Its circumference, as high as a man can reach and pass a tape line around, is a few inches less than one hundred and fifty feet. This is beyond the measurement of any tree in the Calaveras grove. The height is estimated at one hundred and sixty feet, and a part of the top lying on the ground is over one hundred feet in length.

The iron-clad fleet of Turkey comprises 15 frigates or corvettes, armed with Armstrong guns. There are 6 frigates—Massudien, 14 guns, 7,200 horse-power; Nusrettieh, 12 guns, 800 horse-power; Azizieh, 16 guns, 3,050 horse-power; Osmunieh and Orkamieh, 16 guns, 3,050 horse-power; Aschar-i-Tefzik, 8 guns, 3,568 horse-power. The corvettes are as follows: Makadem-Hair, 4 guns, 3,250 horse-power; Feth-i-Bulend, 4 guns, 3,250 horse-power; Idiladieh, 5 guns, 300 horse-power; Avni-Illah, 4 guns, 400 horse-power; Main-Zafer, 4 guns, 400 horse-power; Aschar-chef-tek, 5 guns, 350 horse-power; Neduh-im-Schef-tek, 5 guns, 350 horse-power; Luft-i-Dschelik, 5 guns, 200 horse-power; Hifs-e-Rhaman, 5 guns, 200 horse-power. Besides this fleet, the Turkish navy has 14 monitors on the Danube and in the lake of Scutari; 3 ships of the line, carrying 254 guns; 5 frigates, mounting 208 cannon; 7 corvettes, with 100 guns; 4 schooners, 16 guns; 6 yachts and 7 avisos, with 63 guns. There are also several vessels on the stocks, making altogether quite a respectable fleet, which the British bondholders have a decided interest in—since they paid for it.

Railway News.

Track-laying has been commenced on the Dayton & South Eastern R. R. between Dayton and Xenia.

It was announced that a corps of engineers in the interest of the Cumberland Valley R. R. would run a line between Mount Alto and Waynesboro.

The Quincy (Ill.) City Council is considering propositions to survey and prepare plans, specifications, etc, for a general system of sewerage in that city.

The Montreal, Ottawa & Western R. R. is now completed as far as Lachine, and trains are running to that point. It is intended to complete the road to Grenville before December.

There are 48 lines of railroads and branches in California, with an aggregate length of 1,799¼ miles; of these 14 are private roads, with a length of 58¾ miles, There are 126½ miles of narrow-gauge railroads in the state.

The Emlenton and Shippenville road, Pennsylvania, is open for traffic as far as Dogtown. The track is laid to Pickwick, and the grading completed to Jefferson Furnace, within two miles of Edenburg, to which point it was expected to be completed by November 10.

Tue San Diego *World* says that the people of San Bernardino propose to build a railroad to Colton, and to continue it to Mound City, so that when the Southern Pacific R. R. Company has completed its line between Mohave station and San Gregorio pass, it may be induced to connect at San Bernardino.

Arrangements have been completed for the construction of the Bethel and Rochester Narrow-gauge R. R., which is to be operated by the Central Vermont under a lease. James E. Batchelder & Co., of Springfield, Mass., are the contractors, and the work is to be finished by September 1st, 1877.

During the six months of the Centennial the Pennsylvania R. R. Company started 22,917 trains from Jersey City alone, westward, made up of 127,080 cars, and carrying not less than 7,500,000 passengers. This includes no way passengers, and only the travel in one direction.

The Pennsylvania R. R. Company has circulated a congratulatory address to its employees for their faithful attention to duties during the Centennial. The Baltimore & Ohio send their employees a check, beginning with the conductors at $100 and so gradually down to the firemen, who received $40 each.

The Atlanta & Richmond Air Line R. R., extending from Charlotte, N. C., to Atlanta, Ga., 266 miles, is to be sold on the 5th of December next, in pursuance of authority contained in a certain deed of trust, and it is rumored that an effort to buy it will be made by John M. Robinson, President of the Raleigh & Gaston Seaboard and Roanoke Railroads and Bay Line steamers.

About four miles of the Portland, Dalles & Salt Lake Railroad have already been graded, and work is being pushed forward with energy, with the intention of completing it to Malade, Oneida county, Idaho, a distance of fifty miles, the ensuing winter. Another road is also said to be in contemplation from Corinne to the mammoth coal mines recently discovered in the western part of Wyoming. The coal vein is represented to be 1,000 feet thick, with only a few thin strata of rock between, and to cover an area of not less than thirty miles square, the coal making a splendid coke.

Contractors' Intelligence.

The question of building a new court house has been voted down in Scott county, Ill.

The line of railway from Broad Cove, C. B., to Whycocomagh, has been contracted for by the Inverness Coal, Iron and Railway Company. Work will proceed immediately.

The Wheeling *Intelligencer* of Nov. 16 says: "Mr. W. W. Halloway, of the Cleveland & Pittsburgh R. R. Company, met with a Chicago party at the McGlure House last night and contracted for a large sale of iron.

The Board of Supervisors met Monday the 13th inst., to canvass the vote of Linn county, Iowa. They will also transact other business, among which will be the letting of the bridge across the Cedar, at Mount Vernon.

The Atlanta *Constitution* says: "The splendid building to be erected by the government opposite the State House will soon commence its growth upon the solid foundation which marks its proposed site. We are reliably informed that Mr. L. L. McCleskey closed a contract with the Bodwell Granite Company to transport the granite, purchased by the authorities, via Port Royal (of which route he is the Southern agent) to Atlanta. There will be nearly three hundred car loads of the rock, making one of the largest freight contracts ever made here. Our readers will naturally wonder why Stone Mountain granite, which is only sixteen miles away, was not used—a query readily answered by the fact that the Bodwell Company, whose quarries are fifteen hundred miles distant, underbid our home company many thousand dollars."

Reading Cases.

In the first year of our publication we had calls from nearly all of our subscribers for "reading cases" or "binders" which we supplied; the double rates of postage in the following season completely cut off the trade in them, but we can now again send them by mail, postpaid, at the manufacturer's retail rates. The advertisement will be found in another column, and we can recommend these cases to all who desire to preserve clean and complete files of ENGINEERING NEWS or of any other publication.

Improvement of the Lower or Des Moines Rapids, Mississippi River.

BY MAJ. E. HUDSON WORRALL, U. S. ENG.
(Asst. Engineer in Charge).

(*Concluded from page 366.*)

While the work was progressing actively at the lower lock, trouble not induced by high water had interfered with the operations on the canal prism and embankment. The contractors for that portion of the work as its magnitude began to develop, and as the demands of the officers in charge for a more energetic prosecution of their contract with greater facilities in the shape of machinery and men, proved entirely ineffectual, it became manifest that they were totally incapable of fulfilling the terms of their contract, and on the 25th of October their agreement with the government was declared violated, and was abandoned by the Chief of engineers.

Advertisements were again published, offering the excavation of the prism and building the embankment wall to the lowest responsible bidder.

In the meantime, as the work had been left in an unfavorable condition for re-letting, the officer in charge was directed to make use of the means at hand to place it in the best condition possible. It was in the midst of winter, everything was frozen, ditches had to be dug, drains made, guard banks extended and raised, extra roads made, etc., but all was done that could be to accomplish this end.

Under the terms of the advertisement bids for doing so much work as the balance of the appropriation would cover, were opened November 18th, 1868, and the contract awarded to Mr. J. J. Dull, of Harrisburg, Pa. He at once made arrangements to purchase the tools of the late contractor, and by January 2d, 1869, with an improved plant consisting of locomotives and dump cars built expressly for this work, and a large force of men and teams, started in the middle of winter to work out this problem. A mild, wet winter followed by a rainy spring, together with unusual high water, rendered the transportation of earth and rock very difficult, but despite these drawbacks, considerable progress was made.

The operations of the lower lock during the years 1869 and 1870 were carried on as effectively as possible under the circumstances. One serious mistake made by the contractor, and in direct opposition to the advice of the officers in charge, was to build his timber cofter only twelve feet high. The known variation of the water at this locality, some twenty feet, would naturally admonish a man engaged in works exposed as this was to the fluctuation of the river, to guard against such contingencies to the best of his ability, but with an erroneous notion of economy twelve feet was adopted instead of fifteen, and frequent overflows, causing expensive delays was the consequence.

The first contract for stone, which had been taken at entirely too low figures, came to a sudden conclusion, like the contract for the prism and embankment work, and was abandoned. This proved an inconvenience to the lock contractor, but on account of the many stoppages from overflows did not materially delay the masonry, and General Wilson immediately entered into a contract with Messrs. Wells, Timberman & Co., who furnished all the stone required from the celebrated Sonora quarry, and faithfully fulfilled their agreement.

The energy of the lock contractor in prosecuting his work, when not interfered with high water, was marked. Steam drills for excavating the heavy mass of rock preparatory to laying the foundations of the immense walls; derricks moved by steam power for handling and placing the large blocks of stone; railroad tracks with small cars darting hither and yon for delivering the different kinds of material: crowds of men and teams at work, and all surrounded by the turbid waters of the Mississippi, gave life and animation to the scene that those who watched its progress will not forget. The known insecurity of the frail timber coffer proving to be a constant impending danger, seemed to increase, and to crown all, the tremendous blasts made from the large holes put down by the "Burleigh steam drill," which were exploded at noon and night, recalled the heavy bombardments of the war, through which a large number of the men had passed, and inspired them almost with martial ardor.

This lock was built by authority of Congress in exact accordance with the plans approved by the Secretary of War. The massive walls, the complete arrangements for filling and emptying the chamber by means of culverts behind the main walls with lateral openings, the heavy gates and peculiar facilities for manipulation, both of the gates and wickets are more fully described further on.

Work on this portion of the improvement was continued until October 29th, 1870, when, on account of the exhaustion of the appropriation, the contractor was notified to cease operations by the officer in charge, now Col. J. N. Macomb, U. S. Engineers, who had relieved Gen. J. H. Wilson, at his own request, September 30th, 1870. Consequently, during November, by order of Col. Macomb, precautions were taken to preserve such of the work as had been done from the action of water and severe frosts of winter, as no further appropriation could be expected until the next meeting of Congress.

THE SECTION WORK.

In the meantime work was progressing on the sections between the locks. Earth and rock were excavated rapidly, the embankment being built and protection wall laid. Congress, in a spirit of unwonted generosity, especially appropriated, December 23d, 1869, two hundred thousand dollars for this improvement, enabling the officer in charge to renew his contract with Mr. Dull, who took into partnership Mr. Geo. W. Williams, of Keokuk, a railroad man, endowed with the energy and push of the American railroad man, and who, in this new position, proved a valuable acquisition.

The excavation of the prism and construction of embankment being now in good hands, the work went bravely on; but most of it being located in the river, it was subject to the vicissitudes of that changeable stream, numerous leaks and slides occurred, floods delayed the work and innumerable yards of unfinished bank was washed away; and although the expense of these losses and delays had to be borne by the contractors, they energetically prosecuted their work until the appropriation was expended, when, with rare public spirit, they proposed in writing to carry on the work without estimates or pay until Congress should make the usual appropriation. This proposition was accepted, and the work went on.

It was now May, 1870, and the appropriation was not received until July. The indebtedness of Dull & Williams was paid off, new contracts entered into with the same parties, and the work pushed rapidly through the summer and fall months, during which season a low water stage generally obtains, and a large amount of work was done. This last contract carried the work on the canal section to the 9th of November, 1870, when the money having been expended and the advices from Congress about any more appropriations being indefinite, the contract was stopped and everything done to place the entire work in security for the winter.

These precautions in regard to the sections were not required, for Congress upon being memorialized by citizens of St. Louis and several other towns along the river passed a bill granting an appropriation for this portion of the work January 18th, 1871. The same contractors again went to work. During this season but little trouble or expense was experienced from the fluctuations of the river. Several leaks sprung, but preventive measures were taken and no damage ensued, and the work was closed in the whole length of the prism, so that by July 31st, 1871, the main bank had been connected to the upper corner of the coffer-dam surrounding the lower lock, making a continuous bank above ordinary high water from Nashville to the end of the lock pier at Keokuk. All of this bank was protected on the outside by rip-rap, most of it laid in form and a large portion of the inside was also covered with stone.

Now more than four-fifths of the work had been done, and a prompt appropriation would have finished this portion economically; but such was not to be the case. A strange notion of retrenchment seemed to pervade the councils of the nation, and orders were given to prepare the sections to remain idle for an indefinite time, and right well was this neglect paid for by the Government.

The summer of 1871, as mentioned in the record of the section work was a most favorable season for prosecuting this immense undertaking, and every advantage was taken of the weather and low stage of water that the money on hand would admit of. Contracts were awarded to bidders for work on the middle lock and also for resuming work on the lower lock. But the means were inadequate, and when the allotments to the locks had been expended, the lower lock was still in a very unfinished condition, and only the foundation of the middle lock started.

Now was the great hiatus on this improvement, and the false economy of ill-judged retrenchment applied for political motives to strictly commercial objects fully illustrated.

For nearly a year the great work was allowed to remain idle, and expensive damage was the consequence. Leaks started through the half-finished banks, slides took place where the protection was unfinished. The bottom of a large portion of the prism where excavation had been completed, and also at places where it was incomplete was soon covered from one to three feet deep with debris from the lateral streams emptying into the canal; a forest of weeds took possession of the bank, mink and muskrats were busily engaged erecting their little homes in the now abandoned prism and boring through the earth embankment, much to the detriment of the work.

The officer in charge was powerless to prevent this wholesale destruction; the appropriations were exhausted; without means his hands were tied. Complaints were sent to Washington concerning this condition of affairs, but retrenchment was the watchward—no matter what interests suffered—no matter who went to the wall, retrenchment was the order. Another excuse was found for not making an appropriation. The cost of the work had already nearly equalled the amount of the original estimates. A board of engineers was ordered to investigate this state of affairs and try to discover where the public money had gone, and why, like the cry of poor Oliver, the demand should be made for more. They came; they investigated; they reported; the money was found properly and legitimately expended, and this very condition of affairs had been predicted, in a letter of Gen. Wilson's to the Department of December 3d, 1868, wherein he says, "that with partial appropriations the entire work *must* be increased *very materially* in cost and be greatly delayed in its final completion."

The Presidential campaign, in which the rallying cry of the Republicans was retrenchment, and during which Gen. Grant was elected, seems to have been the prime cause of this suicidal policy, as in June, 1872, another little drib of an appropriation was made, and during the following autumn work was resumed where it was practicable along the line and at the locks.

Great difficulty was experienced in preparing the section so as to resume; leaks through the unfinished bank had to be patched up; weeds and shrubbery removed, in order to relay the tracks; ditches dug to drain the excavation pits; approaches which had been washed away renewed, and an expensive clearing up of the collection of sediment for a year at those points where it was decided to re commence.

The condition of the locks was better than the line of the canal; considerable delay, however, was caused even there, on account of an unfinished work remaining idle so long, but operations were carried on rapidly during the autumn until the cold winter of 1872 necessitated another stoppage.

The winter of 1872 and 1873 was exceptionally severe. Frost penetrated the embankment thirty inches. The water in the prism froze solid to the very bottom. The swift current over the rapids was covered with a thick coating of ice that would bear up teams and wagons with the heaviest loads, and this icy stillness over the rapid river remained unbroken until March 9th, 1873, when, yielding to the approaching spring, the force of the mighty current increased by the accumulations of the melting snow, broke its crystal bounds and dashing the masses of ice on either shore, caused it to crowd and gorge on to the very height of the embankment, and in some places rearing in a dazzling crumbling wall above the top, tumbled, crushed into a harmless mass, upon the inside slope. No damage was sustained, the work proved substantial and not a sign was left of the trial it had undergone during the few hours of the breaking up of the icy barriers of the great river.

After the weather had become settled in the Spring of '73 work on the middle and lower locks was resumed with considerable activity. The huge dimension

stone were being delivered daily, the clicking of the stone-cutters' tools, the hoarse cries of the masons from the walls, the rattling of machinery, cars and wagons moving rapidly over the works was exhilarating, and seemed to promise that the end was drawing near.

During this season a proposition was submitted to the Department for building sluices around the locks, of sufficient capacity to control the surplus water carried into the canal by the numerous streams emptying therein during their frequent floods. These being absolutely necessary, increased the cost of the work and should have been included in former plans and estimates, but heretofore, from some unaccountable reason, they had been dispensed with until their importance becoming apparent, their construction by days labor was recommended. This inaugurated the system of labor by employes instead of contract, and an extract from the report of the officer in charge in reference to it, says he is "justified in saying that it is by far the best plan for the United States to do this class of work by their own employes. It has cost much less than any contract work on this improvement. The employes of the United States have no other interest than to carry out to the fullest extent all the instructions received, and to do the work in the very best manner, and a majority of the funds appropriated go directly to the laborers employed, benefiting the many, and not, as under the contract system, a large percentage profiting the few."

To return to the section work. During the month of July, 1873 a new letting was held to finish the excavation in the prism, the guard lock and the channel approaches at both ends of the canal, but owing to the strong opposition made by competing bidders the contract was not awarded until the latter part of August, nor did the new contractors get to work until September, 1873.

In the mean time the government laborers built a coffer dam around the proposed channel excavation for an entrance to the guard lock, repaired some of the leaks underneath the embankment, reopened the drains and ditches through the prism, which had become clogged on account of the work lying idle for so long, which facilitated operations and dispensed in a great measure with the expense of pumping.

The contractors with a plant of two narrow gauge locomotives, fifty cars and the necessary appurtenances went to work energetically, and by January 12th, 1874, the excavation of the new channel was completed and the dam allowed to fill. They now transferred their machinery and men to the coffer dam, which in the mean time had been constructed around the channel at the entrance to the lower lock, but ere they had got well to work the high water of March flooded the dam, and they were obliged to find work in the upper part of the prism and the excavation for the foundation of the guard lock.

As high water continued in the river during the Summer of 1874 and the lower cofler dam remained flooded, what work could be done was carried on at the sluices around the two locks, in the prism, and for foundation of the guard lock. The only masonry laid, except at the sluices, was the circular wall connecting the upper inside wing wall of the guard lock with the rip rap wall on the canal bank. The work was now being pushed vigorously. Congress was importuned to furnish sufficient means at one appropriation to complete the improvement, and the consummation of the plans of this great work, which would overcome this first obstruction of the navigation of our national highway, seemed to be within the grasp of the officers in charge, and renewed enthusiasm and energy actuated all.

Except the final finishing of the prism all of the excavation between the guard and middle lock was done this summer, and the contractors concentrated their force in the lower coffer dam. The Government employes were engaged quarrying stone and laying rip-rap wall, prolonging the bridges and erecting dams for silt pools at the mouths of the two largest creeks that debouch into the canal, and preparing the concrete foundation for the immense walls of the guard lock, which was to be built entirely by hired labor, and the officer in charge desired that no pains should be spared to make it a structure superior in all respects to either of the other two locks which had been built by contract, and also to be done in less time and at less cost; consequently the foundation was substantially laid in and flooded so that it should become well set before the superstructure was placed on it, and the force during the winter was employed cutting stone for the walls.

Meanwhile during the month of September, 1874, the contractors had removed all of their plant to the coffer dam below the lower lock and the excavation of the channel was this time carried on successfully to completion, such rock and earth as was suitable being used to raise the embankment of the canal to grade, and the balance placed along the shore of the river between the lower lock and Keokuk bridge abutment, making a very convenient levee; and on the 25th of December, 1874, after an official inspection, the channel was found cleaned up nicely to grade, the slopes true, and everything finished in accordance with the specifications. This closed the contract system of work on this portion of the improvement.

The extreme cold weather of the winter of 1874 and 1875 prevented continuous work. The mercury fell to zero and below, where it remained for weeks, everything froze solid, ice made upon the rapids where the current is from three to five miles an hour, twenty-six inches thick, men could not work exposed to such a temperature, and it became necessary to suspend operations until spring.

By that time the last appropriation being available, work by days labor was inaugurated all along the line. The middle lock and sluice were finished. The work on the lower lock and sluice had been completed, and laying masonry for the guard lock with the new and approved machinery in the shape of two travellers spanning both side walls was commenced in earnest.

The floods that interfered during the summer of 1875 with the balance of the improvement were not felt here. Every day was taken advantage of and the work completed during the fall. It now stands a monument of the best cut-stone masonry on the river, and thoroughly fulfils what was intended by the officer in charge, when in his report he said "that no pains would be spared to make it a structure superior to either of the other locks, and that it would be done in less time and at less cost than either of them." That prediction was fulfilled, for by November, 1875, the last stone in the lock walls proper was laid.

The objective point during the season of 1875 was to push the work so far forward as to admit of the passage of boats through the canal some time during the fall, consequently every exertion was made to that end. The rip rap protection for the inside slopes of the banks was built up to high water mark as far as possible. The prism was mostly cleaned up. The big crevice leak below the middle lock through which poured thousands of gallons of water was blasted out, refilled with concrete and puddled. The sluice at the guard lock was nearly completed. The old timber on hand for the gates having become useless from dry rot, was condemned; new timber was purchased, and work on the gates for the middle and lower locks was going on rapidly. The machinery for operating the gates and wickets, made from an original design of Major Amos Stickney, the officer in local charge, was constructed and partially placed in position at the middle lock. This plan consists of a system of pullies, chains and wire ropes, operated by a pump forcing water into hydraulic cylinders sunk behind the walls back of each gate, connected by means of iron pipes, with an engine situated near the head of the lock, and such as has been tried works admirably, so that when finished one man at the engine can handle the massive gates and wickets with ease and precision.

While work upon the canal proper was being thus energetically carried forward towards completion, the final consummation of the original plan of this great work—the through cut at the upper chain and improvement of the channel between there and Nashville was also undertaken. A new survey was made so as to definitely locate the channel and verify former surveys, by means of a very ingenious sounding apparatus, invented and managed by Major E. F. Hoffman, assistant engineer, from the Rock Island Improvement. The results from this proved that former calculations had been partially erroneous, and a much larger quantity of rock required moving than had been estimated for. Nothing daunted, however, by this discrepancy, work on the huge coffer, designed to enclose the channel, to be excavated through the solid rock, was commenced in June, and by the 13th of August, 1875, was closed, and pumping began

The projecting and energetic pushing of this monster coffer to completion—being five thousand seven hundred and eighty-two feet in length and enclosing ninety-five acres of the waters of the Mississippi, has been one of the great engineering feats of the age, and in spite of the frequent mishaps, the crushing of the walls of the coffer, were weakened by the washing out of underlying fissures; the unprecedented high water of the fall and winter of 1875, when once in September, and again about New Year's day the flood waters of the great river, seemingly intent upon preventing the desecration of its rocky bed, rose in their might and overwhelmed the petty structure made by man, the channel was successfully finished.

These frequent floodings were the source of great inconvenience and expense, and occurring at a season of the year when low water generally obtains, were unexpected and unprovided for, tools and materials were lost, the work terribly delayed, gangs disorganized and men demoralized. The perseverance that actuated the officer in charge, was tried to the utmost, but as fast as the dam broke, which sometimes happened during the dark hours of the night, in spite of the efforts of the men working by the flickering glimmer of their torches in fighting the persistent water which, seeking out a weak spot would come crushing and surging over the works; repairs were made and the work continued. The length of channel enclosed by this dam was three thousand one hundred and sixty feet, two hundred feet wide, and owing to the frequent mishaps, it cost a little more than had been anticipated. But when from the exhaustion of the appropriation it became necessary to stop the work, the channel was completed except a small portion of the head, which can be removed by means of chisels. This undertaking was fought out courageously to the end, and has been done for nearly one half the cost of the same kind of work heretofore done under contract for the Government.

The rock taken from the excavation was placed in a bank parallel with the line of channel, fifty feet removed, located upon the west or Iowa side, raised above extreme high water and making an excellent guide for navigation.

The balance of the channel improvement from Montrose chain to the approach to guard lock at Nashville, a distance of about three miles, was partially improved this season by means of smaller coffers where required and the use of the chisels. These chisels are immense steel pointed masses of iron weighing about nine thousand pounds, raised in a frame work similar to a pile driver, by means of an engine on the boat, and so located as to drop upon the rock bottom that is required to be excavated and gradually to crush it into pieces suitable to be dredged up and removed. This work was carried on until the running ice during November made it necessary to lay off the boats and harbor them for winter.

The great work had now been brought nearly to a close; the locks finished, part of the gates put in, the machinery for moving them well advanced towards completion, the prism ready for the water, and the protection walls (except in the lower level) brought up to high water mark, so that the finish could be put on at any time whether the canal was in use or not.

The grand object of opening the canal for navigation seemed within the grasp of the officers. Such, however was not to be.

The accumulation of silt in the prism from the creeks which had never been properly protected (until the last year); the large quantities of material left scattered over considerable space from unfinished contracts, which had been stopped prematurely on account of inadequate and insufficient appropriations; the unprecedented high water of the fall and winter that backed up into the prism delaying all operations and necessarily increasing the cost, together with the casualties of the Montrose dam, used up the available means, and on the 26th of February, 1875, orders were reluctantly issued to cease operations everywhere and prepare the work for an indefinite season of idleness. This too when it was known that two months' work would carry the improvement so far ahead as to allow it to be used for the purpose intended. The circumstances were at once reported to the Chief of Engineers at Washington and steps taken by him to obtain sufficient funds through Congress, then in session, to allow operations on the

locks at least to proceed far enough to become of some use to the navigation of the river. But it was not to be. Again had arrived the quadrennial cycle in American politics.

The spirit of investigation had taken possession of the House. The status of the political aspirants to the White House occupied the sole attention of Congress. Nothing like an appropriation could be obtained. Personal ambition and the success of political cliques, no matter what material interests of the people suffered in the mean time, ruled the hour, and this great work, instituted for the benefit of millions of our countrymen, —a work national, not political; an improvement of a world's commercial highway; a work that would cheapen the transportation of the food of millions, and be of incalculable benefit to mankind for the gratification of petty political partizanship is allowed to remain idle and go to ruin from inanition. But at last, after seven long months of inactivity—after the heavy floods of the spring of 1876, and exceptional heavy rains of the last season, during which the prism of the canal has been again partially filled with debris from the creeks; portions of the unfinished protection walls washed out and almost everything connected with the improvement swamped for months, and which could all have been avoided by an appropriation at the proper time and the canal been in use during this present season of low water, congress has graciously donated another partial modicum of the amount asked for, which, by strict economy of expenditure, may possibly make the great work available for the purpose intended by the low water season of '77.

THE APPROPRIATIONS.

Following is a list of the appropriations received and amount of money expended on the canal:

1866, June 23d	$200,000
1867, March 2d	500,000
1868, July 30th	300,000
1869, May 11th	180,000
1869, December 23d	200,000
1870, July 11th	400,000
1871, January 18th	341,000
1871, March 3d	250 000
1872, June 10th	400,000
1873, March 3d	400,000
1874, June 23d	400,000
1875, March 3d	480,000
Total,	$4,051,000

This is the amount the canal has cost the Government so far, and, with the present appropriation for 1876 of $230,000, which will certainly render it useful for navigation, the total is, $4,281,000. Rather a large sum, but by making a comparison of the following table of figures between contract price and the cost of labor by employes, and at the same time taking into consideration the suicidal policy of Congress, of making partial appropriations far a part, during which time the work has laid idle and necessarily deteriorated, it will be easily understood why the building of the canal has cost so much more than the original estimates.

COMPARATIVE COST.

Comparison of cost of different kinks of work on this improvement done by contract and labor hired by the United States—the lowest prices for contract work are taken for this object.

Kind of Work.	*Lowest Contract Price.*	*Labor Price.*
Cut stone masonry, per yd	$8 00	$ 5 65
Concrete foundation, per yd	5 55	2 85
Rock excavation, per yd	2 40	1 75
Earth excavation, per yd	45	33
Slope wall, per yd	1 00	77
Wrought iron, per lb	10	03
Rock excavation in coffer dam, per yd	11 25	5 00

WATER POWER—ITS AVAILABILITY.

Frequent inquiries are made concerning the water power, if any, that is made available by the building of the canal along the rapids, and a few thoughts on that subject are appended.

The middle lock, located just below Price's creek, and with a lift of eight feet, holds the water at an elevation never below extreme low water at Nashville, the head of the canal, five miles above, which elevation can be carried by means of a flume below the lower lock, a distance of two and three-fourths miles, and be there used for power with an extreme fall of eighteen and three-fourths feet, which can be utilized to a greater or less extent the whole year round, except in cases of extreme rise, similar to that of 1851, when, of course, the power is lost, though high water seldom lasts more than a few days.

This will be better understood by a comparison of the figures of the datum elevation of the canal.

The surface of extreme low water at Nashville, which is carried to the middle lock is 27.70. Extreme low water at the lower rock is 8.95. This gives a difference or fall in that distance of 18.75 feet, which is the greatest fall that can be obtained. Now the highest that will be allowed in the upper level, or above the middle lock to prevent that structure from being flooded is 30.70. The highest recorded water at the lower lock, which occurred in 1851, and has never been reached since, was 29.80, making a difference of fall of 0.90 tenths of a foot. This is not available for water-power but as previously stated, such an extreme height has never been known to last more than a few days, and delays caused on that account would be inappreciable Calculations made from the daily records kept of the changes in the river at the lower lock for the last ten years show that a mean head can be obtained for most of the working days of the year, of say 14 feet. This fall or head with a discharge of say 800 feet per minute, and a 26 inch turbine wheel gives a result of nearly 22 horse-power; with a discharge of say, 16,000 feet per minute, and an eight-foot turbine, the result would be nearly 383 horse-power. These results vary as the head changes or the size of the turbine is increased or diminished.

Having simply glanced at the power to be obtained, it remains to show how it can be utilized.

The most feasible method is by tapping the upper level of the canal where Price's creek debouches into the prism and building a head race or flume from there, ollowing the line of the present location of the C. B. & Q. R. R. track, down to Brown's warehouse on the levee, from which point, small flumes radiating to mills located upon the edge of the levee can be built, and the power utilized.

It is not proposed to make any estimate as to the cost of this work, but simply to show the best method of using the canal improvement as an adjunct to the power at this point.

The length of this flume or head race would be 2¾ miles, the width would necessarily be determined, (say ten feet or fifty feet) by the amount of water required. The excavation to a great extent would be made through lime stone rock and have to be carefully puddled, while a timber flume would probably be required at the lower end.

An enterprising company might build this head race and in a few years, by attracting sufficient capital to use it, would undoubtedly realize a fine profit on their investment.

Another method of utilizing the water power is by building a short head race from Price's creek to just below the middle lock, at the Hornish property, and from thence down as needed, which will make a flume of about half a mile long. There a head or fall can be obtained of from four to five feet, generally five feet all the year around, except of course in extreme high water —with a tail race or discharge into the lower level of the canal. But this small head would require the use of large turbine wheels, certainly nothing less than five feet, which would give only thirty horse-power; or, if a ninety-six inch turbine was used, the power obtained would be but eighty horse.

With these few hints the subject of the utilization of the water power of the canal is left in the hands ot the community.

NOTE.—Since the above was written the appropriation has been cut down, by authority of the President, one-half. This reduction, of course, changes all calculations, but it is hoped by the officer in charge, that enough work can be accomplished, even with the reduction, to allow of the passage of boats by next fall. Whether such will be the fact or not time alone can tell.

"The Manor of Pittsburgh."

"It embraced within its bounds five thousand seven hundred and sixty acres, and allowance of 6 per cent. for roads, etc. The survey began at a Spanish oak on the south bank of the Monongahela, thence south 800 perches to a hickory, thence west 150 perches to a white oak, thence north 35 degrees west 144 perches to a white oak, thence west 518 perches to a white oak, thence north 758 perches to a post, thence east 60 perches to a post, thence north 14 degrees east 208 perches to a white walnut on the bank of the Ohio' thence up the river 202 perches to a white walnut, thence crossing the river obliquely and up the south side of the Allegheny 762 perches to a Spanish oak, the corner of Croghan's claim, thence south 60 degrees east 249 perches to a sugar tree, south 85 degrees east 192 perches to a sugar tree, thence by vacant land south 18 degrees east 236 perches to a white oak, thence south 40 degrees west 150 perches to a white oak, thence west by claim of Samuel Sample 192 perches to a hickory, thence south 65 degrees west 74 perches to a red oak on the bank of the Monongahela, thence obliquely across the river, south 78 degrees west 308 perches to the beginning, at the Spanish oak."

The Great Sub-Marine Tunnel.

At the recent convention of the Oriental Congress at Marseilles, Mons. De Lesseps, alluding to the submarine tunnel between France and England, and the creation of a sea in the desert of Sahara, by the influx of Mediterranean waters, spoke of the projected grand Central Asia line of railway to unite Europe and Asia by running to Peichauer in Anglo-India. He said that the scheme had received the approval of the Russian Emperor, and that the preparatory surveys would soon be completed. The railway outpost from Europe is now Orembourg, upon the Oural, in Asiatic Russia, and the line in question will reach Peichauer by way of Samarcand. Between this latter point and Orembourg there are numerous large towns, notably Tashkend, with a population of 150,000, but between Samarcand and Peichauer the country is very sparsely settled until Indoukouch, the ancient Indian Caucassus, is reached. The work is stupendous, but offers far fewer engineering difficulties than were required for cutting the Isthmus of Suez. This work required the invention of new instruments.

Narrow-Gauge Railways.

Whatever may be said for or against narrow-gauge railways theoretically, they seem to be rising rapidly in favor in many sections of this country, mainly because they require a much smaller original outlay than standard-gauge roads, and because they bid fair to occasionally make a return on the capital employed in construction, even when their lines traverse poor districts. Various causes have combined to create a demand for railways in many portions of the United States which have never been able to pay the interest on the cost of standard gauge roads; and the narrow-gauge system furnishes a method for diminishing the losses of the stockholders in projects designed to develop sparsely settled and comparatively unproductive districts.

The report of the Boston, Revere Beach and Lynn railroad furnishes some interesting data relating to the operation of a short narrow-gauge road in Massachusetts. It has already declared a dividend, after accumulating a surplus. A new narrow-gauge, running between Grass Valley and Nevada City, claims similar results. It by no means follows that these reports furnish conclusive data on all points in dispute, but they manifestly serve to strengthen the conclusion that in districts which are too poor to support a full fledged railway less money will be lost on narrow than on standard-gauge roads.—*Railway World.*

LIVADIA, the present residence of the Emperor of Russia, is an estate on the southwest coast of the Crimea, at about a league and a half from a little town called Yalta, in the Goverement of Taurida. Yalta is about thirty-six miles from Sebastopol. Livadia, which is placed on a crest of rocks running like a cornice along the Black Sea, is a private estate belonging to the Empress. It was presented to her by the Czar a few years after their marriage, his Majesty having bought it from Count Potocki. The property has an extent of about four miles in diameter, and is crossed by the post road which starts from Sebastopol, where the railway stops. On entering the domain one sees at each extremity of that road pillars surmounted with the arms of her Majesty, who was, as is known, a Princess of Hesse. The house on it is exceedingly modest in extent. Its construction dates from the commencement of the centvry; it is in height only a chalet in the Russo-Italian style, like those of the pleasure residences around the estate, that is to say; built half in stone and half in wood. In the middle of the park is another house smaller than that of the Empress, which is reserved for the Czarewitch when he comes there to stay with the Court.

A FOREIGN OPINION OF OUR EXHIBITION.

A late number of the *Revue des Deux Mondes* contains an article by M. Louis Simonin, upon the Centennial Exhibition, in which he expresses his views upon its industrial and commercial aspects. What intelligent Europeans, who look upon the matter from a more impartial standpoint than we possess, think of our exhibition, cannot fail to be interesting to Americans.

The feature in which it stands particularly eminent above its predecessors is, in his opinion, Machinery Hall. While machines for spinning and weaving have been more in number and made more noise at other World's Fairs, here were found in great abundance and variety those productions of inventive genius for shaping iron and wood, beside some novelties in the way of apparatus for dressing stone. We ourselves have thought that in the direction of labor-saving machinery of various kinds might be seen our greatest progress and success. The great Corliss engine appeared to M. Simonin to be the most remarkable thing in Machinery Hall, and one of the greatest curiosities of the exhibition. As to another class of exhibits, particularly belonging to engineering, he is moved to say—"there are some twenty kinds of drills which bore automatically, and one is astonished at one thing only, and that is, that the Americans have not put in the charge of powder and ignited it,"—to make the circle of machine performance complete, we suppose.

He finds much fault with the system of awards, in that there is but one grade of medal for all, with distinguishing features to be added in the accompanying statements, and thus the juries strove in vain to so vary the praise that the proper distinction could be shown. A notable instance of the working of this arrangement has been seen in the case of the almost numberless competitors in sewing machines. Immediately upon the awards being made public, they all rushed into print, in their advertisements that such and such a machine received the highest award. The result is that no one is advanced beyond the position occupied before the competition. Whether the revision of some of the awards and the attempt to satisfy the complaints of exhibitors met with any measure of success we very much doubt. M. Simonin says "Really it is carrying too far the love of uniformity of democratic equality, and this singular way of awarding prizes and of compensating no one seems to us irrevocably ill-judged and to be condemned."

The lessons which the Exhibition teaches are best given in a translation of his own words. which we extract from the New York *Post*.

"America can feed Europe with corn, wheat, preserved meats and live stock as it has supplied it with cotton; it has clothed Europe and it can nourish Europe. It can get along without Europe as far as regards iron, steel, copper, machinery and most of the manufactured products. It will not cease, however, to give Europe the gold and silver which is needed for all transactions, for the mines of the United States yield more than the mines of the whole world. As for coal, America will soon produce as much as England, that is as much as all of the rest of the world, and its carboniferous deposits are twenty times greater than those of England.

"America will learn more and more how to get along without Europe, but Europe will not be able to get along without her. It is truly a new England which is rising across the seas, and which already threatens the old England in all her markets. The commercial interests of France are also threatened; even American wines are competing with ours. The connoisseur alone demands the wines of France.

"But what is still graver is the fact that the Americans are getting hold of the processes, the sleight of hand of our workmen. Already in the manufacturing of jewelry, watches, bronzes, furniture and artificial flowers they produce an article which bears the real stamp of solidity and good taste. In these departments the American is more to be feared than the Englishman because of his situation, which climate, a mixture of races and an incessant contribution of European and Asiatic immigration render peculiarly favored. Switzerland is already in a state of agitation over the success of American watches. In carriage making, cabinet work, glasswork and pottery the United States is almost the peer of France and the other great nations. In other things they have got ahead of us; and all this in spite of the high price of labor. It may be said that we are their instructors and masters, as Italy was for us at the Rennaissance, and that they are destined to surpass us some day, as we did the Italians. Venice, Milan and Florence taught us formerly how to melt glass, to weave silk and velvet, and soon we got ahead of them. Will the same thing happen to us in respect to the United States?

THE REMOVAL OF ENGLISH STEEL MANUFACTURE TO AMERICA.

The Sheffield *Daily Telegraph* announced that the well-known Sheffield firm of Messrs. Sanderson Brothers, steel manufacturers, had abandoned the attempt to compete with American makers of steel in the face of the high protective duties, and had resolved on establishing works at Syracuse, New York, carrying the war into the enemy's camp. The firm say, in announcing their intention:—"Inasmuch as the founders of our house were the pioneers of the American trade, and were conspicuous among the earliest manufacturers of cast steel after the death of the inventor in 1776, it seems appropriate that we should also be the first to accept the logic of events, and transfer the manufacture of English steel to America." The operations at Syracuse will be under the charge of a steel maker practically trained at the Sheffield Works, aided by skilled workmen from the same place, and the "peculiar modes of preparing crucibles, mixtures for melting, methods of manipulating, and all confidential information of whatever kind employed in the Sheffield process of steel manufacture" will henceforth be available at Syracuse.

The *Iron Age* regards the step taken by Messrs. Sanderson as "an admission on the part of those with the largest interests at stake that England can no longer manufacture steel for the American market, and that the only way in which Sheffield can hold its own against the competition of American makers is to come here." Mr. W. Matthieu Williams, in a recent letter, believes that the promoters of this enterprise will derive considerable advantage from it. The movement will be watched with great interest by many, for, if successful, the example will be further followed. Any calculations based upon tariff rates are, of course, dependent upon changes of those rates, and may be seriously influenced by their abolition at some future time, if the end to which the free-traders aspire is attained.

THE preparation of the Tables given in "Sanitary Engineering" and the careful arrangement of the plates have taken more time than we anticipated; it is not our intention to allow Mr. Latham's book to drag until it becomes tiresome, but on the contrary we are very anxious to push it forward to completion with all possible speed, as we have a much larger project already mapped out upon which to commence as soon as our present enterprise is finished.

WE have received from W. C. Stripe a book containing the "Plans and Illustrations of the Canal for Improving the Des Moines Rapids of the Mississippi River, from which we intended to compile plates illustrative of the interesting paper of Mr. Worrall on that improvement recently published in ENGINEERING NEWS. We have been much pleased in looking over these drawings and we are sure all readers of E. H. Worrall's paper will regret our inability to reproduce them. We take this opportunity of acknowledging the kindness of Mr. Stripe.

Since publishing this interesting article we are in receipt of a letter from Mr. Worrall desiring us to state that he holds no rank in the U. S. Army, but fills the position of an Asst. Eng. on the works.

Annual Meeting of the Chicago Chapter of American Institute of Architects.

The regular annual meeting of the Chicago Chapter A. I. A. was held Thursday September 28, 1876, at the Tremont House Club Rooms, Chicago.

The President, Mr. P. B. Wight, made an impromptu address to the Chapter reviewing its work for the past year, mainly dwelling upon the evident lack of interest that had been manifested by quite a number of its members, who had failed to be present at the meetings, and who by their indifference, assisted to depress and retard the spirit and progress which the Chapter was possible and capable of making.

He thought it might be mainly due to the fact that the dues of the Institute were considered to be illy proportioned to the Chapter dues, and it was undoubtedly for this reason alone that the Chapter had already lost some members, and of the apparent lack of interest by others. He considered that it was an evil that could be remedied, and recommended the Chapter to instruct the Secretary to enlarge upon the subject in his annual report to the Institute.

The President further stated that he considered it encumbent upon every member of the Chapter to present some subject, or to provoke discussion, which should be of interest to the profession, and particularly to that of the Chapter members, and that each member should do his duty in this respect, nor speak of lack of interest until he had done what he could do towards making the meetings profitable and interesting.

The President then reviewed the proceedings of the Chapter for the past year, and although the attendance had been small many of the meetings had been instructive and interesting to those in attendance. Reports of proceedings of sister chapters, discussions in relation to public buildings, papers by members upon construction, questions of architectural duties and honorable practice, had been referred to the Chapter; it could not be said but that the Chapter had made some progress, it only required the individual energy and interest of each member to make the future condition what it should be, namely, an active and useful association, and he had hopes that such a position would be attained.

The roll of the Chapter was then called and the minutes of the last meeting were read and approved.

The executive committee's report was read and their proceedings were approved by the Chapter.

The Treasurer presented his report for the past year, and Messrs. Bauer, Cochrane and Hamilton were appointed Auditing Committee upon the Treasurer's report, with instructions to report at a future meeting.

Report of committee on Admission was read and approved.

The annual election of officers being next in order, the Chapter re-elected by balloting upon the whole, the following officers, viz.—P. B. Wight, President, Augustus Bauer, Vice-President, Henry L. Gay, Secretary, James R. Willet, Treasurer.

The motion was made and seconded that the Secretary be empowered to appoint and elect members to the standing committees.

In addition to the officers, President, Secretary, and Treasurer of the Chapter, the Secretary appoints and elects as members of the Executive Committee L. D. Cleveland and Samuel A. Treat.

In addition to the officers, President, Secretary, and Treasurer of the Chapter, the Secretary appoints and elects as members of the Committee on Admission, William A. Boyington, Samuel Street, and Augustus Bauer.

The election of the officers, completing the regular business of the meeting, discussion upon the Institute and Chapter dues was taken up, and the general sentiment was for a reduction of the Institute dues; and the Secretary was instructed to present to the Institute the opinion of the Chapter, and requesting that the Institute take action upon the matter, with a view to a reduction.

On motion to adjourn, it was seconded and carried.

HENRY L. GAY, *Secretary*,
Chicago Chapter A. I. A.

A special meeting was held at the Tremont House Club Rooms, Thursday, Nov. 23d.

The meeting was called for the chapter to give its expression of regret for the death of A. H. Piquenard, architect of Springfield, Ill,. and to make a record of its esteem and fraternal feeling for the deceased. On motion which was carried, the President was nominated a committee of one to draft the following resolutions which were unanimously adopted by the Chapter.

"The Chicago Chapter of the American Institute of Architects, having heard of the death of A. H. Piquenard, Fellow of the American Institute of Architects, hereby makes the record of the sorrowful event.

'The Institute has lost one of its most talented members; the public one of its most conscientious and devoted servants. Mr. Piquenard was respected alike by the profession to which he belonged, and the community that enjoys the fruit of his labors in many public buildings which he was chosen to erect. He was a gentleman, an artist and a scholar, a devoted husband and father, and a public-spirited citizen. His own works will be his best monuments. We mourn his death as a brother lost and extend our condolence to his afflicted family."

Motion to adjourn, and carried.

HENRY L. GAY, *Secretary*

Correspondence.

JOLIET, ILL., *November* 18th, 1876.

Editor ENGINEERING NEWS: *Sir*:—Having noticed a criticism adverse to Nickel and Strassberger's new method of connecting a Surveying Instrument to the tripod, we would like to make a statement of our experience with this arrangement. As we have constantly used it for eight months, we believe ourselves able to render a correct judgment as to the merits of the same.

In the communication published in your issue of October 28th the writer asserts, that the projections on the lower plate and the tripod head soon commence to wear grooves in each other and that this grooving prevents the effective joining of the instrument to the tripod. To this we must reply, that so far no grooving or perceptible wear has taken place with our instrument, the arrangement is very nearly in the same condition it was in when delivered new, and its effectiveness unimpaired. The fact is that hardly any wear takes place, as the instrument wants only ⅛ of a turn while the ordinary screw requires 5 or 6 turns or about 30 times as much. Besides, very little friction takes place on the projections, but principally on the shoulder of the tripod head and the lower face of the plate.

Judging from the instrument now in use by us, we believe that 30 years constant use would not wear out these parts. Both of these parts appear to be made of hard bell metal. Regarding the assertion that the instrument will shake loose by comparatively slight jarring we must say, that this has not happened to us a single time. A moderate tightening binds the instrument as safe and lasting as an ordinary screw. The detaching also requires no more strength than does an ordinary screw.

In conclusion we must say that we consider the new method employed by Messrs. Nickel and Strassberger superior to any other that we have seen or used and we believe that it can not be improved upon.

A. J. MATTHEWSON.
H. WHITLEY, *Assistant*.

Personal.

Mr. H. A. Rust, whose energy and ability as General Manager of the American Bridge Co. has done so much to secure to that company the enviable reputation which it now holds, has been elected President of the company in place of A. B. Stone, who has occupied that position since its organization, and has recently been elected President of the Poughkeepsie Bridge Co. Mr. Rust has been engaged in bridge building since 1854, being first associated with L. B. Boomer. On the organization of the present company he early assumed its general management and his present elevation to the presidency is but a fitting acknowledgment of his services in its behalf.

Civil Engineers' Club of the Northwest.

Chicago, Nov. 28th, 1876.

The December meeting will be held at the Sherman House Club Rooms, at 4 P. M., Tuesday, December 5th.

Paper for the evening and topic for discussion, "Removal of Ice by Blasting."

L. P. MOREHOUSE, *Secretary*.

On the Construction and Maintenance of the Public Highways.

BY MR. E. B. ELLICE-CLARK, C. E.
From "The Builder."

The construction and maintenance of high-ways must form at all times a most important work of sanitary authorities, not only because of the increased comfort to the community of well-kept roads, but because of the increased cost of locomotion and cleansing and discomfort of badly-maintained roads. Unfortunately, the construction and maintenance of highways is a subject that few surveyors of the present day give much attention to. It is popularly supposed that the mere covering of a road with broken stone is sufficient to form a good and permanent highway; this being the view taken by a large number of those who have the control over roads, the consequence is that in many cases throughout the kingdom the roads are in a bad state of repair, and cost a larger amount annually than is necessary for cleansing and watering. Roads, too, are frequently maintained by committees, who have but a slight and imperfect knowledge of what their duties are; and I take it to be the duty of every surveyor of highways not only to advise his committee of the quantities of materials that are required to maintain these highways under their direction, but further to inform them of the best known means of maintaining the roads in a maximum efficiency at a minimum cost. Thus the surveyor secures the valuable aid of disinterested persons living at all parts of the district, in supervising the repairs, and indeed, without a large and expensive staff, with anything like a long mileage town roads cannot be kept as they should be unless the surveyor is thus assisted. I therefore propose in this report, as briefly as possible, to point out the cardinal points to be observed in the construction and maintenance of roads in Urban Districts such as Derby.

The direction of roads is usually determined by private capitalists, but it should, in my opinion, form the subject of legislative enactment, that all new roads should be laid out in certain directions, especially in rapidly increasing towns; for were a preconcerted plan to be carried out piecemeal by owners of property, not only would a large amount of money be saved, but public convenience would be served in a much greater degree than it is at present, where every owner of property makes roads to suit the fancy of his surveyor or himself, acting frequently in ignorance, when he would only be too glad to follow out a plan which, in nine cases out of ten, would cost him no more money, become as available for his own purposes, and be of much greater convenience to the public at large. I am therefore strongly of opinion that where new roads are projected the sanitary authority should exercise their discretion not only as to the constructive portions of the roads, but also as to their direction; for we must not forget that all these new roads ultimately form part of that network of highways which is the only means of communication from one part of the district to another, and where roads are judiciously laid out at first, the stoppage of one street like South Street, by the Great Northern Railway, would be a matter of slight instead of great and permanent inconvenience.

The next thing to be considered is the gradients of roads. All roads should be as nearly level as possible. To illustrate this, I may cite the instance of Bridgegate. Suppose from its lowest point to the summit at King St. we had a perfectly level roadway instead of having a gradient of 1 in 32, as we have, every horse drawing a load, would be able to draw one-quarter more than it does now; and as we have 1,268 carts passing up this street daily, one-half carrying 1½ ton each, 238 more tons could be taken to and from the town with the same amount of horse-hire each day. Then, again, roads with steep gradients cost fully one-third more to repair than flat roads. In the case of Bridgegate it is three times more than London Road; consequently it is difficult to form an idea, without going into detail, of the increased cost to the community of steep roads, which should in all cases, where practicable, be avoided, and any extra expense in making urban roads level at the first outlay will fully repay the authorities by the ultimate diminished cost of cleansing and repairing, to say nothing of the saving to the community by the increased weight that can be drawn with the same amount of horse-expenditure. One of the most important matters in forming roads is the cross section, *i. e.*, the shape from kerb to kerb. The prevailing profile now adopted is that of an elliptical projection, high in the centre, and sloping gradually to the channels,—a section which is, in my opinion, the reverse of what it should be for roads sufficiently wide for four vehicles to pass abreast; and no main roads should be made a less width than this. My objection to the existing section for such roads as Friar Gate or London Road are, that if the road is made sufficiently flat for carriages to run easily over all parts of the roadway, the gradient is not sufficient to carry away the water which lies in the center, and renders the crown rotten. In surburban roads the traffic is nearly always in the center, consequently they are worn down most unevenly; this is manifestly a wrong result, as roads should be of such sections as no preference would be shown to any portion of their surfaces.

The prevailing section of roadways comes about by engineers following the footsteps of Telford, who constructed all his roads to the elliptical section; but the conditions existing in his time are most dissimilar to the conditions and exigencies of our day. Telford's roads were highways from city to city, having few vehicles running on them. The great objects then were not what they are now, to present over the entire area the hardest and least slippery surface, to give the firmest foothold to horses, and to stand the daily wear and tear of thousands of vehicles heavily laden, but to keep the roads dry and sufficiently hard in their centers to bear the traffic of a few vehicles, rarely exceeding a hundred daily; the elliptical section suited those times and requirements; vehicles rarely meeting, consequently the inconvenience arising from the steep sides of roads was not felt, nor was the center worn away, as the traffic was trifling. My own opinion is that all main roads should be made sufficiently wide for four vehicles to pass abreast, and where the traffic is considerble, and the rainfall is such as to necessitate pitched channels and storm-water sewers, the channels should be in the center instead of at the sides, thus obviating the tendency of vehicles to slide down the sides towards the kerb; the slopes to the center channels from the kerbs need only be very slight, especially where the hard metal is used to coat the surface, in which cases a maximum of one in forty might be adopted. The advantages claimed for the section of road with channel in the center are:

1st. In the case of a macadamized road with gullies and pitched channels, half the cost of both these serious items would be saved.

2d. The gullies need not be trapped, but be left open as sewer ventilators.

3d. Carriages would use all parts of the road surface except the channel, producing a uniform wear.

4th. The "slop" which is now swept to the sides of the road, thrown up to the carts, frequently bespattering pedestrians, would be swept to the channel in the centre, and be the farthest possible distance attainable away from the foot-passengers and shops.

5th. In the case of a crowded thoroughfare, the channel would divide the up and down traffic without the aid of police.

The objections that have been raised to this section of roadway are:

1st. The carriages slide down towards each other, especially in frosty weather.

2d. A large stream of water washes away the metal at the channel.

My answers to these are, that the slope of the road to the center will only be slight, just sufficient to carry away the water, and not sufficient to cause the tendency of vehicles to slide to the centre to have any foundation in practice.

The second objection is overcome in the case of sewered streets with frequent gullies, for the water disappears down these before it has assumed sufficient volume to become a stream having velocity enough to wash away the metal.

I am quite aware that this section of road-way is contrary to all the practices and prejudices of surveyors in this country; but I believe, if tried, we shall obtain better roads at less cost both in construction and maintenance, better lighting, and a more effectual mode of ventilating our sewers, all objects of paramount importance to Sanitary Authorities.

The next important matter in connection with roads is the nature of the materials of which they are formed and coated. The ordinary mode now in practice is to lay in a bottom of hard core, rammel, foundry cinder, or some such kind of material, to a depth varying from nine inches to one foot, without any uniformity as to size. The practice of the first road-makers in the world, viz., the Romans, and also the great road-makers at the commencement of the present century, was to lay courses of large-sized stones by hand on the road-bed to form a foundation, which, as a matter of fact, was the actual road, the next coating of broken stones being merely a covering to take the traffic wear, and prevent the road proper beneath from being worn into holes. The advantages of this method of forming a road are, that as it has to sustain great pressure from heavy loads and "violent percussion," it forms a solid foundation which is necessary to resist these. In the case where the tyres of the wheels are narrow and the loads heavy, the modern system of roadmaking is most pernicious. Under the old system, this kind of traffic is dealt with much more economically, as the weight is distributed over a much larger area, thus preventing clay and other soft material from "spewing" up when the

road has become out of repair and soddened with wet. We have an excellent example (?) of this in the Mansfield Road, near Little Chester Church, where the surface has been raised very high from constant metalling on a bad bottom, but which no amount of metal short of re-making will form a good road, and where, in spite of frequent repair and scavenging, the road is never in good order.

Another great advantage of forming a rough pavement like the one I speak of is that it forms a drain for the water, which finds its way through the top coating of broken stone,—an especial advantage on a clayey soil like that of Derby. A road formed in this manner will cost but a little more than if formed by the prevailing mode, as stone of a much more inferior quality and less costly character may be used; it will bear a much greater amount of weight; the bottom will not be influenced by the most severe frost and rapid thaws, and a less quantity of broken stone may be used than if the bottom is of small stone or hard core thrown down at random. In addition, the covering of broken granite or other hard stone will last much longer on a foundation of this sort, and the expense of repairing and scavenging will be considerably less. Sir John Macneil, from actual experience, computes the saving by forming a road like this at least one-third the expense of repairs annually, and I believe this to be within the mark.

I should like to say a few words on the use of small round stones (boulders) used on some outlying roads, and state my objections thereto. These small stones, unbroken, being pressed by vehicles against each other, find no "bed" when they come into contact. By such pressure they move, and thus form hills and depressions on the surface; and the joints being large, gaping in fact when compared with those of cubical stones, a large portion of the exposed surface joints becomes filled with horse-dung and mud, which must give an offensive effluvium, and be prejudicial to health. The illustration of McAdam to a Parliamentary Committee, when explaining the advantages of using cubical instead of spherical stones is conclusive,: he had two basins, one filled with marbles of broken stone, the other with spherical stones, and requested the members of the committee to thrust their clenched hands into each basin. They thus had demonstrated to them that they could plunge their hands to the bottom of the latter basin with ease, and the marbles "spewed" up, while the greater the pressure in the other basin, the tighter and more compact were the contents; and thus it is on a larger scale with roads. I therefore recommend you to discontinue the use of all unbroken stone, however small.

I have hitherto been speaking of surburban roads, and if I have digressed somewhat from the original intent of this report, it has been an attempt to show that a large saving in cost, and a greater efficiency in construction and maintenance, may be obtained in the future on those roads where the traffic is not so great as to require paving on the surface. Let me now deal with roads where the nature of the traffic is such as precludes the use of a broken stone surface. Premising that it is difficult to determine where Macadamizing should end and pitching or paving commence,—where it is cheaper to cover a road with small unfixed broken stone or to pave the entire surface with fixed blocks, it would appear, at first glance, that that road which has the greatest number of vehicles passing over its surface should determine this, but I am of opinion that such is not the case. The mere enumeration of the vehicles passing a given point on a road will not enable us, without other considerations, to draw a hard and fast line where it is more economical to pave roads in preference to Macadamizing them. We must also take into account (*a*) the class of traffic, subdividing this into heavily weighted, spring, narrow-tyred vehicles, and carriage traffic; (*b*) the gradient; (*c*) the nature of the bottom; (*d*) the width, and the height of the buildings. In three of these considerations (*a*, *b*, and *c*) the Wardwick has superior conditions to Bridge-Gate: we thus see why the former is a more economical road to maintain than the latter; therefore, every street must be treated on its own merits.

To ascertain whether it would be a saving to pave certain streets, I have endeavored to obtain the cost of repairing and cleansing the same. I have left the watering out of the estimate, as I cannot even approximately obtain figures sufficiently reliable to enable me to produce them here.

(*To be continued.*)

The Results of Engineering.

Professor Fleeming Jenkin, in opening the Class of Engineering in the University of Edinburgh last week, ofiered some remarks in regard to the aims of the profession, and the spirit in which they should be pursued. After defining the work of the engineer as the application of science to the satisfaction of man's material wants, he claimed that every exact science, by which he meant every science the results of which could be numerically expressed, required for its practical application the assistance of the engineer, and that if the historical sciences were less exclusively their own than those which deal with numbers, yet, wherever any science whatsoever was concerned with production or distribution, the engineer could not be repelled as an intruder. No man, he submitted, who loved exact knowledge could fail to find scope for the exercise of his intellect in the practice of the engineer, and that practice, moreover, was curiously suited to men of the most opposite temperament. Two conditions, and these only, were needed. The man must love his work and have ability to perform it. After discussing the question whether the engineer may find in the exercise of his profession the solid pleasure of believing that he is working for the general good, the Professor said:—

"To many of you this question may seem almost idle, but at some time or other to older men the question will at times occur, Why am I working? am I not disquieting myself in vain? Money-making is no great pleasure when once bread for the family has been earned. Social distinction is like the fair fruit filled with ashes. If as older men you are to work with the fire of youth, other motives are needed, and it is no idle question to ask whether in our profession these other motives will rise and lead us on. I for one do not doubt it. By our work we feed mankind, we clothe mankind, we house mankind. Through our work deserts are peopled, and old countries teem with a new life. We promote wealth, which, in its simplest sense, is but well-being. Let who will look backward on a past golden age embellished by a haze permitting imagination to people its pastures with idyllic beings; we face the present with faith in a future moulded by knowledge of the truth. If the husbandman does well producing food, the engineer doubling that food does better. The charitable man gives bread, but the engineer gives work whereby free men may earn their bread. When the engineer cheapens cloth he betters the condition of a man more than if he halved his cloak with a beggar. To cheapen dwellings is better than to build an alms-house. If existence be a boon, and I do not doubt it, the engineer is indeed a benefactor: his creations have called peoples into existence; he creates wealth, and wealth creates men. These things I hold to be his greatest deeds. I almost reluctantly speak of the more direct benefits he confers by giving pure water, fresh air, and cleanliness to the dwellers in towns. The direct action of the sanitary engineer is more visible, but is not really more beneficial than the work of all other branches of the profession. The man who by a better form of bearing diminishes friction, thereby cheapens production, and clothes the poor. Our business is to supply the material wants of men, and he who is doing this is doing well. Though I claim much, do not suppose that I claim supremacy for our work, or call on all to join us. We do good, and we have great scope. So much I claim fearlessly, but I neither say that we do the chief good, nor that we have the widest scope. It is well to remember that man does not live by bread alone, and if the engineer can create a nation he can do but little to determine what manner of nation it shall be. This duty falls to men whom some may call prophets, some poets, some philosophers, some the divine teachers of mankind. We, the men of exact science seeking for material good, do not belong to this band; we can only print their words, spread their doctrine, and follow their guidance. We miss, too, the direct sense of alleviated suffering which must be the physician's chief reward, but yet our steamers fetch his drugs and our mills prepare them. The arts which are concerned in the production of beauty are all, save one, strangers to us, *and even though the province of architecture is our natural heritage, we have failed to claim our right* (!). The history of the great past is of little account to us, neither is it our task to mould or to administer the laws which regulate the relations of man to man. Nevertheless, although these things do not lie in our province, although we may grant that higher duties may fall to other men with greater gifts, yet we may be pardoned if we remember that where there be prophets they will prophesy falsely, that the physician still walks by an uncertain light, that the lawyer may become the slave of words, and the politician may blight where he would fain bless, whereas I believe that I am making no idle boast when I claim that if we as engineers labor diligently in our vocation, whether our opportunities be great or small, we shall not labor in vain."—*The London Architect.*

Rivers and Harbors.

THE CHIEF OF ENGINEERS' ANNUAL REPORT.

In the report of the chief of engineers, just submitted to the secretary of war, are the following estimates for improvements of ports of the northwest: Duluth harbor, amount estimated required for the completion of the existing project, $171 847.11; amount for the ensuing year, $60,000; natural entrances to the Bay of Superior, Minn., and Wis., for the ensuing year, $7,000; Ontonagon harbor, $30,000; Eagle harbor, $50,000; Marquette harbor, $35,000; Menominee harbor, $25,000; Green Bay, $12,000; Harbor of Refuge, Sturgeon Bay canal, $5,000; Ahnapee harbor, $25,000; Two Rivers harbor, $25,000; Manitowoc harbor, $20,000; Sheboygan harbor, $6,000; Port Washington, $25,000; Milwaukee harbor, $69,000; Racine, $7,000; Kenosha, $7,000; improvement of Fox and Wisconsin rivers, $750,000. The following is the portion of the report referring to the harbor of Chicago: "Twelve hundred and fifty running feet of superstructure were built by hired labor over cribs sunk at the south end of the breakwater, completing this improvement to the extent of the approved plan. One thousand feet of protection were added to the north end of the breakwater. Two cribs were sunk in the extension of the north pier, and repairs were made to the north and south piers. A survey of the harbor has also been made under contract. Ten cribs were sunk in the extension of the north pier making the new extension 600 feet, and with the exception of about two full courses for a running length of 600 feet the superstructure is completed under contract. The wreck of the schooner Nicaragua lying in the outer basin, was removed and towed into deep water. The appropriation of $5,000 for the fiscal year ending June 30, 1877, may be applied toward deepening the channel connecting the outer harbor with Chicago river. An estimate of $100,000 is submitted by the officer in charge for extending the breakwater 1,000 feet southerly; of $40,000 for excavating a channel to connect the outer harbor with Chicago river, and of $10,000 for repairs and preservation of existing improvements. The amount available in July, 1875, was $110,056.64; amount expended during the fiscal year ending June 30, 1876, $93,531.72; amount available July 1, 1876, including $2,912.78 due on contracts, $15,525.92; amount appropriated by act approved Aug. 14, 1876, $5,000; amount estimated required for completion of existing project, $150,000; amount that can be profitably expended in the fiscal year ending June 30, 1878, $150,000. The amounts of money asked for other harbors are as follows: Calumet, $5,000; Michigan City, $63,000; Frankfort, $22,000; Manistee, $30,000; Ludington, $26,000; Pentwater, $39,200; White River harbor, $34,500; Muskegon, $3,990; Grand Haven, $38,000; Black Lake, $15,000; Saugatuck, $10,000; South Haven, $70,000; St. Joseph, $16,300; St. Mary's Falls canal, $300,000; Cheboygan, $35,000; Au Sable, $25,000; Saginaw river, $51,900; Sebaming river, $8,000; Harbor of Refuge, Lake Huron, $200,000; Detroit river, $20,000.

English Railway Stations.

The English public have demanded and secured generally very comfortable station houses on their railways. At all important points they have buffets and bookstands, There is no running through the cars of impertinent book, candy, fruit and cigar sellers, and annoying the passengers. The people there would not stand the nuisance, and how the American people put up with it is a mystery. It may pay the railway companies something, but injures them much more by its rendering railway traveling less comfortable. Then,

again, the buffets are very neat, clean, and some of them quite artistically arranged, and the waitresses are comely and polite. It is a pleasure to be hungry enough to desire to eat, while in our railway restaurants it is about all one can do to retain what they eat. The attendants are genarally rough and ill bred, and the viands are uninviting. There is room here for a vast improvement, and it will pay the railway managers and superintendents to look to it. People must travel sometimes. but when station houses are well arranged, waiting rooms comfortable (and where is there one in the United States?) restaurants good, book stands for books and newspapers, etc., well supplied—when all the service is well performed—then it induces people to travel; and this is just as good a place as any to mention the service at the stations. One general remark would cover the whole subject: That in England, and to a great extent on the continent, the employees of the railways at the stations, are not only polite when they are spoken to, but they go further, and will give the traveler any information he or she may want, and, if they do not have it, will seek for it; they express a willingness and desire to make the traveler as comfortable as possible, and this in a respectful and polite manner.

When you arrive at a station a servant of the company will be there with a truck to take your baggage or bundles, show where tickets are to be bought, and follow the passenger until he or she have their baggage checked and they are safely in the carriage, or car as we call it. If the passenger has small bundles, the servant carries them to the car—the like process in departing from a station; the car door is opened by the company's employee, he calls carriage or cab, carries the bags or bundles, places them in the cab, sees that the luggage is brought and put on the cab, and if the traveler desires to know the legal fare of the cabman, will give it. There employees are prompt, perform their duties cheerily and well. Now, contrast this with approaching or leaving one of our railway stations. It seems sometimes as if to destroy all politeness in a man, and make him surly and brusque, the quickest way is to give him a place on a railway. Our managers and superintendents may think all this expensive and unnecessary. They are very much in error. They certainly know that the more comforts they can give to passengers the more inducement will there be to travel; and politeness is at all times, and in all persons who deal with the public, a necessity—it costs nothing. The writer at one time traveled pretty generally over the continent of Europe without meeting with anything but polite attention from the railway employees he was brought in contact with On his return he landed at Jersey City, and if he had required any other evidence that he was at an American railway station, it was furnished him in the rough, disrespectful, and ungentlemanly answer of the first railway official he met with at the railway station in that city.—*Railway World.*

Grindstones at the Centennial.

One of the most attractive exhibits in Machinery Hall was made by J. E. Mitchell Philadelphia, and consisted of a column formed of grindstones, these were nicely adjusted as to size and finished perfectly true so as to form the exact shape of a Tuscan column twenty-six feet high. Thirty-eight grindstones were required for this purpose which were composed of as many varieties of grit used in the mechanic arts. Besides this column there were shown 15 mounted grindstones of different sizes, for use in machine shops and for other purposes; part of these were hung in iron boxes made very tight and strong, and others in wood frames which have the advantage in price. A collection of large stones from 1000 to 4000 lbs. each were shown such as are used for grinding saws, files, edge tools and cutlery; for bead stones in nail works and for finishing the iron work of locomotives. An illustrated pamphlet containing a description of all the kinds of grindstones in common use, together with directions how to hang and use them, may be had free by addressing J. E. Mitchell, York Avenue, Philadelphia, to whom three medals were awarded.

NOTES.

Mr. R. D. Fletcher, of Titusville, Pa., has been appointed receiver of the Pennsylvania Transportation Company.

GRINDSTONES AT THE CENTENNIAL.

Gen. Herman Haupt has resigned his position a chief engineer of the Pennsylvania Transportation Company.

FOR Four Dollars we will send Volume Two, and the numbers of ENGINEERING NEWS from December 1st, 1876, to January 1st, 1878

Mr. Charles C. Gregory is appointed chief engineer, and Mr. W. D. Barclay assistant engineer of the Eastern Counties Railroad; headquarters at New Glasgow, Nova Scotia.

Mr. A. B. Stone, president of the American Bridge Company of this city, has been elected president of the Hudson & Poughkeepsie Bridge Company in place of Mr. John F. Winslow, resigned.

The question of the water supply for the Canadian Parliament Buildings has been settled, the government agreeing to pay $8,000 instead of $12,000.

VOLUME Two of ENGINEERING NEWS is neatly bound in paper covers; it has 156 pages of reading matter and the price is only *One Dollar.*

The floating debt of the Philadelphia and Reading railroad Company is stated to be between $8,000,000 and $9,000,000.

Major J. A. Smith, Engineer Officer of the Seventh Light House district, Key West, will relieve Major W. L. Merrill of charge of engineer duty on the Monongahela river.

"VARIATION and Vernier Readings," "Standard Measurements," "The Solar Compass," "The Center of a Section," "What is due North?" and "The Subdivision of Fractional Sections" are a few of the subjects in Volume Two of ENGINEERING NEWS that are of especial interest to Land Surveyors.

The trustees of the East River Bridge have decided to appoint an assistant engineer to take charge of the work in case the severe illness of Mr. Roebling should render it necessary. Proposals for the wire to be used in constructing the bridge will be received until the middle of December.

VOLUME Two of ENGINEERING NEWS contains 133 Decisions of the Supreme Court of the United States, and of the courts of the various States in the Union upon questions relating to boundaries, surveys, etc., etc., compiled expressly for it by an eminent lawyer of this city whose specialty is disputed boundaries.

The Clinton Bridge Co., of Clinton, Iowa, is a vigorous young institution. It began business only about a year ago, and has already put up bridges in ten States. Its shops comprise a main building 40x30 feet, with additions 250 feet in length. an 80 horse-power engine, and a machine that dresses the four sides of timber 16½x12 inches at the same time, or three sides of timber 20x12 inches. Shops are soon to be added for making the iron work in connection with the building of iron bridges. The company have already put up or have under contract 8,000 feet of iron and combination truss bridge. Among their completed structures are a Howe truss combination over Rock River at Moline, Ill., 750 feet; a combination bridge for the St. Louis, Bloomfield & Louisville narrow gauge road, 400 feet., 3 span; and an iron bridge over Cedar River at Vinton, Ill., 560 ft., 4 spans. For the latter contract ten companies competed. The bridge is a double intersected Pratt truss of wrought iron. The guaranteed strength is 80 lbs. to square foot of roadway, exclusive of the bridge itself—such a load only straining the materials to one-fifth their ultimate strength. The committee appointed by Vinton county to examine the bridge, express the greatest satisfaction with it, and are proud that it is the work of an Iowa company.—*Chicago Railway Review.*

The Keystone Bridge Co. has completed the Green river and Bardwell's Ferry bridges, on the Troy & Greenfield R. R., Massachusetts. They are now erecting the false works on which to raise the immense channel span (520 feet) over the Ohio river, for the Cincinnati Southern R. R. If weather is favorable it is expected that the spans will be completed by Christmas. The 300 feet spans are finished. They are erecting the Attica bridge for the Toledo, Wabash & Western R. R. and iron bridges on the Evansville & Crawfordsville R. R., and iron bridges for Galveston, Harrisburg & San Antonio R. R. in Texas, over the Guadalupe, Salida, Cibolo and Tio Geronimo rivers. Numerous other iron bridges for Eastern and Western railways and for roadways are now under construction in the shops. They are also employed in constructing wooden bridges for the Lewisburg Centre & Spruce Creek R. R. and erecting an iron bridge for the city of Philadelphia. The contract for the high bridge of the West Chester & Philadelphia R. R., at Media, (three spans of 157 feet each) and the roof of the Provident Life & Trust Co.'s new building, Philadelphia, have just been awarded the Company. The shops of the Company are running double turn with two sets of men. Their new fire-proof building, 80 by 400, is nearly completed. This will so increase their facilities as to enable them to promptly fill their large contracts.—*Chicago Railway Review.*

RESISTANCE OF RAILWAY TRAINS.

The number of the *Journal of the American Society of Civil Engineers*, for October, contains a communication from Mr. P. H. Dudley, C. E., of Cleveland, Ohio, the inventor of the Dynagraph. This apparatus, for determining the resistances offered and the work done in drawing railway trains, was described in the NEWS, No. 4, Jan. 22d, and some account of experiments was given in No. 18, April 29th; we will not therefore repeat the description here. At that time we had the pleasure of inspecting the instrument in this city, fitted in working order to a car. In the communication above referred to Mr. Dudly gives an account of a few experiments with cars and trains, and accompanies it with several lengthy tables and five diagrams. While a great number of experiments under various conditions must necessarily be made before all the phenomena, as shown in the traction curves, can be explained, enough has been already accomplished to show what can be expected of this invention, and to point the way to some decided improvement in rolling stock, permanent way and speed.

We wish our space would permit the reproduction of the original communication, but we can only at present refer interested readers to the above source, and say that we hope, at a future time, to give in our columns some information on this subject from the pen of the inventor himself, who has already favored us with his investigations on heat and combustion.

Two or three deductions which he draws from these experiments are, however especially worthy of notice. It was found that, with the long and heavy trains of the Lake Shore & Michigan Southern Railway, of 650 to 700 tons, it required less fuel, with the same engine (Mogul type) to run trains at 18 to 20 miles per hour, than it did at 10 to 12 miles per hour. It was remarked by Mr. William P. Shinn, who submitted this communication, that "The dream of many of our most prominent railway managers has been to have separate tracks for freight, so that freight trains could be kept at their most economical speed of 8 miles per hour. This dream is thus shown to be—in one of its features at least—one in which the promise, if 'kept to the ear,' would be 'broken to the hope,' and its realization not an advance in economy of fuel or power."

On one trip, of 95½ miles, the engine, drawing 37 loaded cars, weight 709 tons, consumed "8,425 pounds of coal, each pound yielding 296,545 ft. lbs. of power to move the train—less than 3 per cent. of the theoretical value of the coal. In some previous experiments, this engine only evaporated 4.66 pounds of water, per pound of coal." Apparently there is room for improvement here.

On one road where the resistance per ton was 57 per cent. greater than that upon another, the work done per pound of coal was 50 per cent. greater than on the latter line. The fine steel track of the latter was in a great measure offset by the better adaptation of motive power on the former.

The amount of power lost in stopping a heavy train at grade crossings, etc., is shown to be enough to run the train upwards of *two miles* on a level.

Mr. Dudley closes by remarking that "A saving of one pound per ton of friction on our vast railway business would save many millions of dollars to all concerned. To do this does not require an entire revolution in our cars, but slight changes in the brasses and avoidance of many of the now objectionable details of cars.

The importance of this investigation into the means of improvement of transportation, and the reduction of the cost of the same, cannot be overestimated. It concerns railway managers and superintendents; it is of a decided interest to stockholders who would like to see some returns from their investments; and it affects all of us in the charges for passage, or for freight of articles we own or consume. It behooves railway engineers to look closely into this matter, for they are expected to understand the principles of good construction and equipment; while grades and curves improperly lined and surfaced track, joints, fish-plates and numerous other details, all leave their marks on the diagrams.

An effort is to be made to have railroad companies contribute a small sum per month, to be disposed of under such regulations as they think fit. If the attempt is successful the inventor will devote his time to experimenting in behalf of the companies, who are vitally interested, and we may hope for most valuable results.

As the experiments cited in the paper above referred to are few in number, an apology for bringing them forward is submitted in a foot-note, in which the gentleman presenting Mr. Dudley's letter says:—"I present them mainly for the same reason and from the same motive that the opening chapters of a serial story are distributed gratis by our leading sensation story papers, to create an appetite for more, with those of our profession interested in the multitude of questions involved in the economy of transportation by railway."

We sincerely hope that Mr. Dudley may be supplied with the means to prosecute these experiments, which he has heretofore carried on with great earnestness at his own expense, and to work up his investigations into such tables, rules and formulæ as he so well knows will be serviceable.

THE CHICAGO & LAKE HURON RAILROAD.

It is expected that through trains and regular traffic will pass over this line by January 1st. The track on what is called the Chicago & Northeastern Railroad, the only remaining link uncompleted, is, at the present writing, laid from the eastward to within less than eight miles of Lansing, Michigan, and from that point to Valparaiso, Indiana, the line is already completed; the gap will be filled by Dec. 15th. The friends of the road look for a very large through business, as well as a lucrative local traffic. It passes through the best portion of the State of Michigan and, in its course to Chicago, intersects some sixteen railroads. It crosses the Grand Trunk at Port Huron, Mich., the Bay City division of the Michigan Central at Lapeer, the Flint & Pere Marquette at Flint, the Detroit & Milwaukee at Durand, the Jackson, Lansing & Saginaw, the Detroit, Lansing & Lake Michigan, and the Lansing branch of the Lake Shore & Michigan Southern at Lansing, the Grand River Valley division of the Michigan Central at Charlotte, the Michigan Central, main line, at Battle Creek, the Kalamazoo division of the Lake Shore & Michigan Southern at Schoolcraft, the Grand Rapids & Indiana at Vicksburg, the Michigan Central, air line, at Cassopolis, the Lake Shore & Michigan Southern, main line, at South Bend, Indiana, the Indianapolis, Peru & Chicago at Stillwater, the Louisville, New Albany, & Chicago at Haskell's. At Valparaiso, Ind., forty-four miles from Chicago, it connects with the Pittsburg, Fort Wayne & Chicago, over which road it runs to the latter city.

As the distance from Port Huron to Chicago by this line is 320 miles, twenty-five miles less than via Detroit and the Michigan Central, it is likely that much of the freight for the Grand Trunk line which now passes over the Michigan Central will take this new route. This is not, however, a foregone conclusion, for a division of freight receipts according to mileage would give the Grand Trunk the advantage on cars taken at Detroit rather than at Port Huron. The active competition of the great East and West lines renders all outside opinions as to the course of business valueless.

For equipment the new road has one thousand freight cars, obtained from the Grand Trunk R'y., three hundred cars now being built by the Michigan Car Co. at Detroit, and twenty-two new engines. They have also started car shops at Port Huron, and begun to turn out passenger and freight cars.

THE Holly system of water supply has lately been introduced into Garden City, L. I., and apparently to the great satisfaction of the citizens of that place. A trial of the engines and the efficiency of the system was held on the 9th of last month, when quite a number of persons interested in Garden City real estate were present. Everything worked satisfactorily, and now the Garden City people are enjoying the benefits of cheap insurance, and of an unlimited supply of water brought directly to any part of their houses.

THE *Nursery* for December is, as usual, bright with picture, song and story that cannot fail to delight the youngest readers, for whom it is intended and with whom it has become a great favorite. We like to commend anything that is really excellent, and at this season of the year, when parents are thinking of something to please their little ones, we do not know of anything that could confer more pleasure for so small an amount of money than this charming little periodical. Its premium list for the coming year is unusually liberal. Published at 38 Bromfield street, Boston, at $1.60 per annum.

WE are pleased to learn that the system of instruction, patterned after the Imperial Technical School of Moscow, and described in this paper recently, which has been inaugurated this autumn at the Massachusetts Institute of Technology, has been started under such favorable auspices. There are already seventy nine young men practising work at the vise, under the instruction of Mr. Valentine Wallburg. A series of instruction shops will be organized under the same system as soon as practicable, and will in all things be intended to teach the best American methods. We wish all success to this new undertaking, and it is with pleasure that we give currency to their announcement that "If a sufficient number of applications are made before January 15, a class of special students in vise work will be formed, the instruction to commence on the first Monday in February.

AMONG the important engineering enterprises that are now being prosecuted in this country scarcely any are of the magnitude and importance of those which are under construction for the additional supply of the City of Boston with water. We are not at this time sufficiently familiar with the project to enter into a description of it; we hope however we may before many months be able to present the readers of ENGINEERING NEWS with a complete account of the works, together with detail drawings illustrative of them. We are prepared however, to furnish stereoscopic views of the works, taken at the most interesting points, and to an engineer the most instructive. We have at present twenty-eight different views, the numbers and names of which are given in our advertising columns, together with the prices. We are sure that to our engineering friends these glimpses of the achievements of their noble profession will be interesting, and to non-professionals it cannot but be equally so to learn something of the difficulties which it is the daily life and study of the engineer to overcome.

IN his remarks on Thursday evening last, Mr. Latimer did not come prepared to enter very fully into the subject of the Divining Rod; he was passing through the city on his way westward and used the opportunity to supplement the lecture given before the club some months ago. His convictions in regard to the action of the Divining Rod have become greatly strengthened by reason of increased knowledge gained from correspondence with other persons, and also from his own continued experiments, and he claimed that by means of the simple forked switch he could determine the pressure of water, and also what kind of water it was; also of any of the metals and how far below the surface of the ground they were, also of oils, salt-wells, etc. Mr. Latimer's theory is that from every substance in Nature there are thrown out *Emanations* at an angle of 45°, and that according to the affinity between such emanations and a substance on the rod, so will this latter be more or less influenced. Thus a brass key placed on the end of the fork on being brought near to any brass substance will cause the rod to turn down, and so of other substances. Mr. Latimer claims that the moving force is magnetism, and to prove this he finds that by insulating himself there is no movement of the rod.

The remarks of Mr. Latimer were illustrated by experiments which afforded occasion for considerable speculation as to the causes of the movement of the forked rod. The subject was so curious a one and so interesting withal that a large part of the time of the meeting was occupied in informal conversation and experimenting, and certain members of the Club became so absorbed in the fascinating occupation of wandering gravely about the room with forked twigs in their hands, sometimes advancing, and sometimes retreating, but always with eyes closely fixed on the mysterious rod which each clutched with all the strength of his fingers, that a formal adjournment was forgotten, and the meeting finally broke up as train time approached. A committee, however, was appointed to arrange for a series of complete tests by which the most skeptical might be convinced that a new and valuable scientific fact awaited only investigation to become recognized and utilized.

CIVIL ENGINEERS' CLUB OF THE NORTH-WEST.

The 70th regular meeting was held on the 5th of December, 1876, beginning at 4 p. m., in the Sherman House Club Room.

The minutes of the November meting were read and approved.

The Secretary read the following names proposed for membership: Charles Sooy Smith, John W Weston, W. F. Goodhue and Charles G. Artingstall.

Upon ballot Mr. E. H. Mott, proposed at the November meeting, was elected a member.

The Committee appointed at the preceding meeting to submit resolutions concerning the death of William Bryson submitted the following

MEMORIAL AND RESOLUTIONS.

William Bryson, C. E., an honored member of the Civil Engineers' Club of the Northwest, deceased on the afternoon of Thursday, October 5th, 1876, after a painful illness of about three days' duration.

For many years previous to his decease Mr. Bryson was in the employ of the Board of Public Works of this city, and in his capacity of assistant engineer was intimately connected with the construction of a number of the leading public works of Chicago.

Mr. Bryson was born in Edinburgh, Scotland, Dec. 31st, 1818; was educated in architecture and engineering at the Academy of Design, Dublin, receiving several premiums and a medal of the Dublin Royal Society. He was engaged upon the Dublin and Mullingar R. R., Ireland, and the Dumfries and Glasgow R. R., Scotland.

In the year 1847 he came to the United States, and for a time followed his profession in New York city. Subsequently he removed to New Rochelle, West Chester Co., N. Y., and was engaged in laying out the sites of several towns in that county.

In 1856 he came to Chicago and was soon after employed by the Board of Water and Sewerage Commissioners, on the sewerage work of this city, which was then in its infancy. During this period he published in the *Journal of the Franklin Institute* "Tables on the strength of Cast Iron, Wrought Iron and Timber Pillars;" and contributed several articles to the same journal on the strength of materials in general. In the year 1863 he left his employment on the sewerage of this city, at the invitation of Gen. R. G. Delafield, to take charge of the construction of the new Barbette Battery, Fort Hamilton, New York Harbor. Under his immediate supervision the first twenty-inch gun was mounted. He remained in this position under the government until he was called to this city by the Board of Public Works to take charge of the building of the Washington street tunnel. After the completion of this tunnel he was continuously employed by the Board of Public Works until the time of his death.

In addition to the Washington street tunnel he assisted in preparing the plans for, and superintended the construction of, the LaSalle street tunnel, the new lake tunnel, the Land Extension of the new lake tunnel, the superstructure for the water works crib, and the foundations for the engines and buildings of the West Side Pumping Works; which are all enduring evidences of the skill and faithfulness with which he discharged every trust reposed in him. While engaged in the completion of the foundations at the West Side Pumping Works he contracted a cold which ultimately caused his death.

Among the published collection of papers read before this Club are found two for which we are indebted to Mr. Bryson. One, a valuable paper on foundations, the other, "The Goose Quill Business as applied to Water Works Six Hundred Years ago," which contains some interesting and exceedingly odd historical facts of the early efforts of the city of Dublin to supply its inhabitants with water. The oddity of many of the facts adduced are fully in keeping with the title.

Mr. Bryson was more than ordinarily prepared for his profession, from an educational point of view, as compared with other practitioners in this country, who entered the profession contemporaneously with him. And throughout his whole life of varied practice he gave evidence of this early training.

As an engineer he was cautious and painstaking, seldom venturing beyond the bounds of strict practical experience, never going outside of well established and indisputable principles, and always giving safety the benefit of a doubt.

He learned the lesson of extreme care, as he himself said, in his early experience in Ireland, through the failure of the foundations for a culvert, the construction of which he was superintending.

As a man, and citizen, no words of ours can be too laudatory. All who knew him acknowledge his worth, and a large circle of friends unite with his family in lamenting the loss of one who had endeared himself by the possession of so many virtues.

We recommend the passage of the following preamble and resolutions:

Whereas, We, the members of this club, are called to mourn, because of the recent death of our fellow member Mr. Wm. Bryson, therefore:

Resolved, That we recognize in the life of our deceased friend, a bright example of great professional worth, united with sterling qualities of mind and heart, and unsullied integrity and unswerving fidelity to duty in whatever form it might appear; and that in his decease we deplore the loss, to this city, of a skilled and honest public servant, to us of a highly esteemed and valued friend and professional brother, and to his family of a kind and faithful husband and father.

Resolved, That to the widow of our departed friend, and to other members of his family, we tender our hearty sympathy in their affliction; feeling that their loss is our loss; and in this mutual bereavement seek consolation in the thoughts that his end was peace, and that recollection of his virtues will ever endear his memory to us and help us forward in the paths of integrity and virtue which he followed in life.

Resolved, That a copy of these resolutions and of the memoir submitted by the committee appointed for that purpose, be sent to the widow of Mr. Bryson.

L. P. MOREHOUSE.
RICHARD POTTS.
BENEZETTE WILLIAMS.

The report of the committee was accepted and the resolutions adopted as contained in the report.

The Secretary submitted a letter from Mr. E. L. Corthell, relating to a suggestion on the part of the officers of the American Society of Civil Engineers that the Club hold its next annual meeting at New Orleans in connection with the annual meeting of the American Society in April. The subject was, by resolution, referred to the Executive Committee and Secretary, with directions to consider the matter and report upon it.

The Secretary announced that Mr. Charles Latimer was present, and would make some remarks and give some practical illustrations of the electrical powers of the "divining rod," in continuance of the subject as treated by him in the paper read before the Club in February last. Mr. Latimer addressed the Club at some length, and made some experiments to show the practical operation of the rod.

After discussion, upon resolution, Mr. Soulerin was added to the committee appointed to arrange for a comprehensive test of Mr. Latimer's theory, and the committee were requested to report any additional facts or information that they might obtain.

Owing to the lateness of the hour the reading of the paper announced for the evening was postponed and the meeting adjourned.

L. P. MOREHOUSE, *Secretary*.

Personal.

MR. CHARLES A. SWEET, Division Engineer of Canals in Syracuse, has been invited by one of the Brazilian Commissioners to go to Brazil.

On the Construction and Maintenance of the Public Highways.

BY MR. E. B. ELLICE-CLARK, C. E.
From "The Builder."
(*Concluded from page 378.*)

The traction on level roads has been ascertained to be nearly as follows:

Roadway asphalted	1.0
Roadway paved, dry, and in good condition.	2.0 to 1.5
Roadway paved, and in mediocre condition.	2.5 to 2.0
Roadway paved, but covered with mud	2.7 to 2.0
Macadam in good condition and dry	3.3 to 2.5
Macadam wet	3.3
Macadam in Mediocre condition	4.5
Macadam covered with dirt	5.5
Macadam with the stones loose	8.5 to 5.0

This is a low estimate. Some careful experiments give, taking the maximum load a horse can draw on a gravel road as a standard:

On a best broken stone road	3 times as much.
On a well-made pavement	4½ "
On the best stone trackways	11 "
On railways	15 "

Here we see that there is a loss of more than 100 per cent. of motive power between Macadam in a mediocre condition and a roadway paved and in good condition; and assuming that 951 tons are daily carried along a certain road 300 days in the year, and the average friction is 1.20th of the weight, the cost of transporting this burden is £1,664 per annum. If we reduce the traction by one half, as above, we reduce the cost of transport on this road to £832; but, assuming this to be a theoretical supposition, and we take it at half, viz., £416, this would practically be the actual sum saved in horse-hire alone, by having the street properly paved.

We now come to the question of cost of cleansing, etc. Taking the number of square yards of its area at 3,000, in round numbers, we have ascertained that the cost of cleansing the street is £80, 10s. per annum. From careful observation it has been ascertained—that four loads of mud or slop are removed from Macadam per 1,000 yards of surface, to one load per 1,000 yards of granite-paved surface, which is reduced to one-third of a load on a surface paved with wood. I will, however, take the quantity at one-half, as we purpose to use granite as the material for paving this street hereafter; this will save £45, 5s. for cleansing. This calculation does not include the carting of the slop to a shoot, which would bring the total up to £100, a year while Macadamized, and the saving in cleansing if paved to £50, a year. The saving in maintenance will be this: the original cost per yard, including concrete, will be 13s., the cost of maintenance I have estimated at 4d. per yard per annum, the life of the road I have estimated at twenty-five years. This gives us a total cost of a little over 10d. per yard per annum, or £125. for the whole, as against £216, 6s. 6d., the present cost, thus effecting a saving of £94. per annum; add this to the £416, and the foregoing £50, and we effect a saving of no less than £560, per annum to the community at large, to say nothing of the freedom from dust and the increased comfort to every person using and living in the road.

From careful observation I should say, all other things being equal, it is cheaper to pave a roadway having a traffic of one thousand vehicles per diem over its surface than to Macadamize it, and this would be the minimum number to commence paving with.

We must now inquire and specifically lay down what are the requirements for such paved streets. The engineer of Birmingham has admirably set them forth in a recent report to the Council of that borough. He says: "They should be even-faced, firm, hard, as noiseless as possible, able to bear any burden, with sufficient foothold for horses, and capable of being easily cleansed so as to diminish as much as possible the annoyance arising from mud and dust; the nearer these objects are attained, the less will be the wear and tear of the roads as well as of the vehicles; property and health will be less injured, and the comfort of pedestrians increased."

These, then, are the desiderata of Highway Authorities, and, as will be seen at a glance, most difficult of attainment. To obtain noiselessness and the least friction the surface must be smooth; to obtain a firm foothold for horses the surface must have a certain amount of roughness (I use the word in place of a better one which I cannot find, though it hardly expresses my meaning), so that two of the desiderata are inverse to each other, for as we decrease the noise and friction we increase the slipperiness. To endeavor to make these meet the material should be as hard as possible, providing it gives the requisite amount of roughness of surface by attrition.

You are aware that during the past few years various materials have been introduced to supersede stone for paving streets having large traffic and heavy burdens; and though the experience gained by the engineers of London, Liverpool, Birmingham, and Bristol, and other large towns, is of much value, I think we may fairly say that the period of time over which their observation has extended, in reference to asphalts and wood, is insufficient to enable them to come to a final conclusion as to the merits of these respective materials. That this is so may be gathered from the very opposite opinions given,

nearly all based upon short-timed observation or theories. As to the durability, cost, noiselessness, and slipperiness of materials for roads, there should be no doubt whatever; but these can only be ascertained by actual observation, extending over a period of years, in streets with varying traffic as to number and nature of vehicles and weight of loads; and it would be unwise, most unwise, to reject a well-tried material for others, some of which have been pushed into the market without trial of any sort whatever. On the other hand, it would be unwise to expend large sums of money in laying stone pavements if there are other obtainable materials more suited to paving purposes. I shall therefore suggest that trials be made with certain materials. Previously, however, to my so doing, I will proceed to examine their qualities. For this purpose I have communicated with the engineers of most of the large towns, and have personally visited several. If durability and cheapness only had to be considered, so far as my observation goes, there can be no question as to the superiority of granite over all other materials used to pave streets with, more especially if laid so as to form a tram or trackway for the wheels of heavily-laden vehicles to run along. And this opinion is shared by all those who have lengthened experience of the requirements of busy streets; but these are only two of many considerations to be borne in mind. There are also safety to horses, noiselessness, easy traction, freedom from mud and dust. Hence the attempts to supersede the use of granite as a paving material. Probably the desirability of decreasing the noise, caused by the vibration of vehicles in business thoroughfares, has had more influence than anything else in these attempts to supersede the hard granites; and we must bear in mind that however desirable a perfectly noiseless pavement may be, in some thoroughfares it is a question that we can afford to discard, if purchased at too high a cost, viz., those streets, where neither the occupations of the inhabitants nor the pedestrian traffic is such as to force this desideratum forcibly upon us.

So far as I can ascertain, wood blocks, squared like granite pitching, appear to meet more of the requirements than any other of the newly-introduced materials, if we are prepared to put on one side the question of cost altogether; though, on inquiry, I find a host of objections urged against its use, some of which are worthy of attention;—the first being its permeability to wet, the separation of its fibres, and consequent absorption of "dung and putrescent matter," which are said to become "highly obnoxious." Again, it is urged that the blocks are separated by concussion, thus opening the joints and permitting the wet to reach the foundation; the wood thus being constantly wet, in hot and dry weather gives off, in evaporation, very foul matters, which taint the atmosphere sufficiently to injure health. These are allegations difficult of refutation; indeed, by actual observation in some of the London streets I am convinced the entire area of wood pavement is constantly saturated, and that it wears down very rapidly when compared with granite, under the narrow tyres of continuous omnibus and railway-van traffic. How far the objections as to tainting the atmosphere are valid I must leave those who are more competent to judge to decide, and confine myself to its actual cost, durability, and general suitability as a paving material.

In Bristol, one, or a portion of one, of the main streets was laid down, and eleven months after the borough engineer reported that: "The general appearance and surfaces of these pavements continue up to present time in much the same condition as when laid, but I have caused portions of the Wine Street paving to be removed at either end of the street, in order to ascertain its state, and can find no perceptible difference in the same at either opening, there being no appearance of decay. The wear of the surface of the blocks is scarcely perceptible; but at the Union Street end of Wine Street the surface-water has percolated through the joints of the wood to the foundation; this has rendered the pavement at this end of the street less rigid, and the constant working by the passing of the traffic over it has caused several of the blocks to split or crack, and it is probable will necessitate the relaying of this end of the street before long."

Two years' experience enabled Mr. Ashmead to confirm his opinion as to the leakage of the joints destroying the pavement, for he says:—"Although nearly twelve months have now elapsed since my last report on this subject, the general appearance and surfaces of the pavements in Wine Street, Broad Street, and the Exchange, still continue in much the same condition; nor have the portions of Wine Street (relaid by the company) been much improved thereby, as the surface water finds its way through the joints and a larger proportion of the blocks in this street are split or cracked; but the pavements of Broad Street and the Exchange appear to be wearing well, and are more rigid and firm, and free from the defects of the Wine Street pavement. This last paving has now been laid about twenty-three months, and Broad Street and the Exchange about seventeen months."

Writing personally to me, Mr. Ashmead says: "The wood will require repair in four or five years, but the comfort is so great that some people prefer paying for the luxury; but there is nothing like granite for durability and economy." How far we should be justified in laying down certain streets with a costly and luxurious article out of the general rates it is for the local authorities to determine.

The evidence of Mr. Deacon, C. E., the engineer of Liverpool, is to the effect that the pavement laid in Bold Street, in September, 1874, has worn but little.

The borough surveyor of Birmingham says that "wood presents an even surface, affords good foothold for horses, is pleasant for riding over, free from noise and mud,—dust, however, rising rapidly; it is capable of being easily cleansed, but like all other pavements, it is somewhat slippery in certain states of the weather."

I have made observations on the condition of wood pavement in London; they are several, and I have extracted from a recent publication descriptions of them:

Croskey's Wood Pavement.—Several plans of wood paving have been of late years proposed. One by Mr. Croskey was to manufacture cross-grained planks of wood of any length, which, being placed side by side are forced together by pressure, so as to form a compact homogeneous surface of wood, which was to be laid upon concrete. This plan does not seem to have been tried, at least in this country.

Harrison's Wood Pavement.—This system consists of a concrete foundation, upon which strips of wood, two inches by half an inch in thickness, are laid. Wood blocks three inches in breadth, are placed upon these wooden strips, and heated asphalt poured into the joints, which penetrates under and adheres firmly to the blocks.

Henson's Wood Pavement.—The main principle on which Mr. Henson proposes to construct his paving, is placing *felt* on the bed and between the joints, thus giving, as he asserts, an elasticity to the road, and allowing by the felt jointing for the expansion and contraction of the blocks. In one roadway they are levelled on the top edges; in another at every fourth or fifth block; and in another a V-groove is to be cut down the center of the block, the object of this last being to prevent the surface-water from soaking down the joints to the foundation.

The Ligno-Mineral Wood Pavement, which is laid in Grace Church, Fore, and Coleman Streets, possesses certain peculiarities, and differs from others in that it is mostly composed of hard wood, such as elm, oak, beech, or ash, which has been subjected by hydro-carburetted oils to a treatment termed mineralization. The blocks, which are nine inches long, three inches wide, and six inches deep, are sawn at an angle of about sixty degrees, the object of this being to expose the fibre obliquely to the wearing face,and to distribute the weight of the traffic from the one block to those adjacent to it in the line of thrust. On the sides of the blocks, near their bases, a groove is cut, which is filled with an asphaltic mastic (pitch and tar), during the process of laying. The blocks are laid on a concrete foundation, the angle of each course being in an opposite direction to the previous one. The remainder of the joints to the surface are filled in with a grouting of lime and gravel.

Carey's Wood Pavement is perhaps that which can be most rapidly laid down and repaired, and is formed as follows, viz.: the blocks are cut four inches wide by nine inches long, and to the depth of five inches or six inches according to traffic; these blocks are shaped with alternate convex and concave ends, and are laid on a bed of ballast or sand, averaging two inches; the joints which have been left about 3-8 inch wide, are filled with a grout of lime and sand. The advantages claimed for this pavement are, that by the peculiar shaping of the blocks they will not be shifted from their positions; and further, that the weight that may be put on each block is thus dispersed over an extended area.

Messrs. Mowlem & Co.'s method of laying wood paving is to form a foundation of concrete, varying in thickness according to the nature of the subsoil and the traffic; then to pave with blocks of yellow deal, three inches wide and six inches or seven inches deep; the joints which vary from 3-8 inch to ½ inch are filled in with sand and lias lime, and the surface is afterwards indurated by strewing it with shingle.

The Improved Wood Pavement is formed of two layers of one inch boards laid transversely and longitudinally on the old road foundation, which is made up with sand or dry earth to the proper curvature; on these boards wood blocks are placed, the longitudinal joints being kept three-quarters of an inch apart by a fillet (which is nailed to the flooring) and the heading joints butting. The joints from the fillet up to the surface of the road are filled in with fine ballast, run with a liquid tar, and caulked with a machine made for the purpose; the road is then strewn lightly with small gravel and is ready for use. The principal advantage claimed for this system is that the flooring of planks forms an elastic foundation, and tends to distribute the weight equally over the whole pavement, while the additional elasticity will lessen the wear of the blocks.

The Asphaltic Wood Pavement.—The mode of laying this system of wood pavement is as follows, viz:—A concrete foundation, composed of blue lias lime and ballast in proportions of one part of lime to five or six parts of ballast, is laid to a thickness of six inches and to the correct curve of the road. Over this is laid a layer or bed of mastic asphalt half an inch in thickness, upon which wood blocks are placed in transverse courses with the grain of the wood upwards, a space of half an inch (or more if desired) being left between each course. Into the spaces, or joints as they are more usually called, heated asphalt is poured to a depth of from two inches to 2½ inches up the block.

These are the pavements of wood, tried in London and elsewhere, and one cannot but be struck with the fact that only one attempt has been made in the metropolis to preserve the timber chemically, by such processess as Kyan's, Burnett's, Renwick's or Boucherie's.* In my inquiries I have only found another instance where any such attempt has been made, and that is at Sunderland. Here I find, from a report of the borough surveyor, dated 17th December, 1875, that as far back as October, 1867, a strip six feet wide was laid with creosoted Baltic red wood; a strip of three feet wide creosoted beech; and a strip of six feet wide with uncreosoted oak; and it appears that after eight years, with a daily traffic of 1,300 vehicles, the total cost of repair was £101, which was equal to a cost of 6½d. per superficial yard. For the last five years, in those portions where the creosoted Baltic and beech, and uncreosoted oak were laid, no repairs have been necessary. The average vertical wear of the entire pavement has been ⅛ of an inch, the Baltic has been ¾ of an inch, the beech ¾ of an inch, and the oak has not appreciably worn at all. The creosoted timbers are said to be harder than when first laid; the beech and oak are spoken of as being too hard and slippery. The surveyor says that the use of creosoted sets dispenses altogether with the cost of watering. This deduction is questionable, though the results are certainly the most favorable I have obtained, both as to wear and cost of wood pavements.

The method of laying a wood pavement by having longitudinal and transverse boards beneath for a foundation, is, to my mind, a faulty one. In the first place, by personal observation, I have seen a heavily weighted vehicle produce a depression of an inch as it passed along the pavement, which sprang up to its original form as the burden left it. Again, the "elasticity" which is claimed to be an advantage is, to my mind, the reverse. If the pavement sinks beneath the load it has to carry, it is like having a surface of india rubber; with this depression an inclined plane of one in seven is formed with a wheel four feet in diameter, and one-seventh of the load must be raised this inch; and this

*Kyan saturates the blocks with a solution of bichloride of mercury; Burnett with a solution of chloride of zinc to be absorbed in a vacuum; Renwick boils the blocks in coal tar; and Boucherie uses impure pyrolignite of iron.

is continually going on with such a bottom. It is next to an impossible thing for the numerous joints in the area (a diameter about eighteen inches under three tons) thus affected by each wheel to remain water-tight, be they made with asphalt or pitch, and the water must pass through them on to the planking below, which, sooner or later, must be rotted. These open joints in the end must wear the edge of the block round,—a fact I noticed in Birmingham, on close examination, which caused a most unpleasant vibration as a light springed vehicle crossed them.

I am certainly at a loss to understand this insistance of some surveyors for elasticity in a paved road, unless it be for the preservation of the horses' feet, which do not last so long on the "stones" as on a softer road. As for the mechanical effect of traction, it is totally opposed to all laws of mechanics for easy traction; and McAdam's theory, of the top stones rubbing against a concrete bottom, and thus wearing round, and being displaced.—from whence I imagine the present desire for elasticity comes, as the top pavement is a fixture,—is untenable. I think it might be laid down as a rule that the harder the bottom of a road is the better, whether for wood, asphalt, granite, or broken stone, and if you do not start with this initial you will never have a sound roadway. The difficulty to be overcome appears to be in keeping the wet from percolating through the joints, which are made wide so as to give a better foothold for horses. I think it is a questionable mode of laying pitchers, whether of wood or stone. I prefer having the joints closer than I have hitherto seen them for wood; first because there is less chance of the water finding its way to the foundation; secondly, these joint always wear away quicker than the blocks, leaving innumerable places for the lodgment of horse-dung and filth; thirdly, the traffic wearing the pitchers round. A demonstration of this can be found easily. A small joint, so long as it is a perceptible joint, is a preventive to slipping, and enables a horse to rise if it falls.

There now remains an examination of asphalt as a material for paved roads.

The most noted of these is that of the Val de Travers Company, which is described as limestone, containing about 12½ per cent. of bitumen, obtained exclusively from Neuchatel, Switzerland. It is claimed for it that neither "atmospheric heat nor frost affects it." In laying it for roads, it rests on a bed of concrete sufficiently thick to stand the traffic. The asphalt in its natural state, reduced to powder, is brought to the works hot, and compressed with heated irons and rollers uniformly over the entire area to be covered, leaving no surface seams or joints. It is laid about two inches to 2½ inches in thickness.

The next asphalt that has attracted attention is that termed Limmer. This, like the previous material, is laid on concrete. It is brought from Hanover; mixed with a certain proportion of sand and bitumen (the company say that the asphalt contains from seventeen to twenty per cent. of bitumen); heated in caldrons and laid on to the concrete about two inches in thickness, and then is smoothed with irons to the requisite surface.

There are several other asphalts that have been tried, but only to a limited extent, except, perhaps, Barnett's which appears to be a mixture of pulverized iron ore and mineral tar made liquid by heat, and spread, as the other asphalts, about two inches thick.

The battle of the materials is almost as fierce as the "battle of the gauges." The promoters of asphalt and wood pavements both claim the same merits, and there appears to be a diversity of opinion amongst those competent to judge, as to which is the better material of the two. The engineer of Bristol says,—"My experience of asphalt is not large nor favorable: the first cost of Val de Travers was 16s. 6d. per yard, but it has not lasted here more than six years, and is now in a very bad condition; the wood will require repair in four or five years."

No asphalt is to be laid in the Birmingham roadways, as the gradients are so unsuitable.

As a material for footpaths, Mr. Till, C. E., the borough engineer, says,—"I cannot speak favorably of its durability."

The City of London engineer, Mr. W. Haywood, C. E., has prepared an elaborate report on the subject, setting forth in detail the result of his experience of both wood and asphalt; and as no one has either had such opportunities or facilities to come to fair conclusions in the matter, I extract these conclusions *verbatim* from his report. They are:

"1. As regards convenience.—That asphalt is the smoothest, driest, cleanest, most pleasing to the eye, and most agreeable pavement for general purposes; but wood the most quiet.

2. As regards cleansing.—That wood may be kept cleaner than it hitherto has been, but will be more difficult and expensive to cleanse effectually than asphalt. That as both pavements require occasionally strewing with either sand or gravel, there is not much difference between them in that respect.

3. As regards construction and repair—That asphalt and wood, taking all seasons and all weathers into account, can be laid and repaired with about equal facility; but that the smallest, neatest, cleanest, and most durable repairs can be made in asphalt.

4. As regards safety.—That weather considered in reference to the distance which a horse may travel before it meets with an accident, or the nature of the accident, or the facility with which a horse can recover its footing, or the speed at which it is safe to travel, or the gradient at which the material can be laid, wood is superior to asphalt.

5. As regards durability and cost.—That wood pavements, with repairs, have in this City had a life varying from six to nineteen years, and that with repairs an average life of about ten years may be obtained; that the durability of the asphalts is not known, but that under the system of maintenance adopted, they may last as long as wood; that contrasting the tenders for laying and maintaining for a term of years the two best pavements of their kind, wood will be the dearest."

We must remember that Mr. Haywood is speaking of ordinary fir timber unpreserved in any way. Probably his opinion would be materially altered if he was aware of the durability of the creosoted timber in Sunderland.

Mr. Haywood, in reporting on the comparative safety of these materials, says that a horse would travel 132 miles before a fall took place on granite; 191 miles on asphalt; and 446 on wood. This is the experience of London streets; but we cannot be guided by that in Derby. It is the practice in London to move all railway vans, and a large proportion of heavily-weighted vehicles, at a trot. With us such vehicles are transported at a walking-pace, and as accidents increase *pro rata* with the speed and load, we should not be liable to anything like so many.

My own comparisons of these materials are: that for a very large number of streets where the roadway is fairly wide, where there are few shops, and where the occupation of the inhabitants is such as noise would not be a great objection, granite is the cheapest and best material that can be used. That in streets of business, where absence of noise is a desideratum, preserved wood paving is the best, though it is expensive. That asphalt is an impracticable material to use in our town, where it would frequently have a greasy surface, unless there is some means of making it less slippery in damp weather.

I have had submitted to me a model by the Val de Travers Co., which shows an introduction of small iron studs on the surface, with asphalt between; but my experience goes to prove that the mixing of two materials differing so essentially in their toughness and hardness is quite wrong; that the studs would in a few years be left so high by the wear of the asphalt as to be dangerous, and I cannot recommend you to lay any large area with this, though the Val de Travers Co., of Birmingham, are willing to lay a trial piece and charge nothing if it is not successful, and it would only be fair to give them a trial.

NOTES.

The water in the Genessee river is remarkably low.

A bed of fine grey marble has been discovered in Clearfield county, Pa.

A movement is on foot to provide gas works for Alameda, Cal.

Brooklyn's debt has increased only $36,000,000 during the last twelve years.

Seats on top of the Sixth avenue cars, N. Y. This is the London style, but in that city the number of passengers carried is limited.

The Central Refining Company, purchased last week by the Standard Company, has a capacity of nearly 1,000 barrels per day.

The Edgar Thomson Steel Works will not resume work this year. The low price of rails is the cause of their idleness.

Eight horse cars for the Bombay Tramway company, of Bombay, India, were shipped lately from the works of Jones & Co., West Troy.

The two spans of the Lehigh Valley bridge over the Chemung river, near Athens, Pa., which were broken down some months ago, have been entirely rebuilt, and the temporary structure has been removed,

The lease on a thirty acre tract of land in Clarion county, Pa., on which are four wells, producing in the aggregate sixty barrels of oil per day, was recently sold for $40,000,

The East River Bridge has now nine wire ropes in position stretched from the New York to the Brooklyn anchorage, over the two towers, preparatory to the construction of a foot-bridge and other facilities for putting together the cables.

Chili has one million acres under cultivation by irrigation, it being estimated that one-third of the value of the entire farming land of the republic is expended in the enterprise. Wherever irrigation has been introduced the land has increased in value three-fold.

The municipal affairs of Norwich, Conn., are in a sorry plight. The year's appropriations are expended, and a meeting of the citizens refused either to appropriate the $39,000 needed to carry the city through the year or to tell the officials how to get out of the scrape.

Spades are trumps again in Paris, just as much as in the days of Haussmann under the empire. The shovel and the pickaxe are seen everywhere clearing away rubbish to charm the eyes of the visitors to the great exhibition of 1878, which the French hope will eclipse all its predecessors.

The Harbor Board of Baltimore, at a special meeting lately, directed Major Hutton, engineer, to advertise for proposals for repairing city wharves. An appropriation of $5,000 was made by the council for this purpose. Many of the city wharves were damaged by the recent flood when the water extended into the streets.

J. A. Cunningham, Chief Engineer of the Water Works, Sacramento, Cal., reported to the Board of City Trustees that during the week ending November 19th, 8,416,000 gallons of water were pumped, and 6¾ cords of pine slabs and $56.72 worth of pavement blocks consumed for fuel. The works were running 163 hours.

One of the piers of the railroad bridge at Louisiana, Mo., having been undermined by the current, went down a few days ago with a crash, without warning, taking two long spans of the bridge with it. By good luck there was no one on the falling section at the time, and the only loss occasioned by the casualty was that of the property itself, amounting to some $200,000.

The Sturgis *Journal-Times* is strenuously advocating the necessity of better roads, and the editor is right about it. Bad roads kill an inland town surely and rapidly. It is but two or three years ago that a wet winter and spring kept the usually wretched roads leading into Port Huron unusually bad, and travel over them, save on horseback, was absolutely impossible, and the result was that trade fell off and one or two heavy merchants were actually ruined, thus causing a loss of more money than would have been needed to build 80 miles of stone or plank road into the city. Other towns should take warning.

The towers of the new Roman Catholic cathedral, at Fifth avenue and Fifteenth street, New York, have been raised 28 feet during the past year, and are now 150 feet in height. A cross, weighing nine tons, has been erected over each of the transept doors. Workmen are now putting in the outer windows of plate-glass, within which the stained windows will be placed. The latter windows, which number 25, were made in France, and bear elaborate representations of various historical and religious subtects. Two of them, bearing paintings of St. Patrick and the Immaculate Conception, respectively, cost $7,000 each. The cost of the others was about $900 in gold each. The high altar, which was recently received in this country, was constructed in France and Rome from designs by Mr. Renwick, the architect of the cathedral. The cost was about $12,000.

BRIDGE DESIGNING.

We have received a problem propounded by one of our subscribers, who states that he as bridge commissioner, if we understand aright, is building an iron bridge of the Pratt Truss type, 72 ft. span, 9 ft. height, 6 panels, single system, the top chord running but four panels, so that the sloping members at the ends are struts, and the first verticals are suspending rods. Load on bottom chord. Steady load, 2400 lbs. per panel; live load, 7200 lbs. per panel. Our readers can sketch the truss for themselves. Then he writes that three contractors furnished strain sheets with their bids, but that no two of them agreed with one another, nor did any one of them agree in every particular with our correspondent. The discrepancy concerned the web members, that is, the main diagonals in the second and third panels, the counter tie in the third panel, the middle and the adjoining verticals.

At first sight the problem seemed very simple, and we sent him a strain sheet for the braces and verticals; but, upon reading further, we strike what has probably caused the disagreement and trouble. The query is put: If a live load of 7200 lbs. hangs by the first vertical, in what manner will one-sixth of it pass to the further abutment? It is added that, some say that it will go entirely by the upper chord, and not affect the ties; others say that it will go to the extremity of the upper chord, as before, but will then cause tension on the first main tie (by which, we presume, is meant the diagonal in the second panel); others claim that it will go by the upper chord to the middle of the span, there cause tension on the counter, go down the middle post and thence to the abutment by the ties, etc.; still others have figured the strains as though the above weight would pass down the second vertical and thence out. We have reproduced this portion as a remarkable sample of ingenuity in getting things wrong, more remarkable when we are told that these strains have been computed by the engineers of bridge companies.

The fundamental error, in all these suppositions, or ways of getting at the strains, is that a horizontal member is competent to carry a vertical force. If a truss bridge has one or two of its braces knocked out, it does not necessarily fall under its own weight, or even under a little additional live load, for the two chords then act as beams to carry a vertical load. In an iron bridge with pin joints, the upper chord alone can thus act, and not then unless it has the proper connection or continuity at the panel joints. If it is really jointed in both chords, the bridge will fall on losing a brace. No designer of experience would, we believe, rely on this stiffness of the chord to carry any portion of the load, and, even then, the chord is of so small a depth as to be of very little account as a beam. If the chords do act as beams, and the truss as a whole also carries a load, we have yet to see any investigation which will determine the distribution of the load between the two systems.

Any increase of direct strain in a straight chord can only come from the horizontal component of the strain in a brace, the increase takes place where the brace abuts, and the strain in the chord will be constant until it meets another brace. Of course we except the case where the floor timbers rest on a chord between panel joints. This being true, the only course for the strain from the load at the bottom of the first vertical, in its movement towards the further abutment, is down the diagonal in the second panel, For this load alone the strain on the diagonal would be compression, and, as this member is intended to be a tie, it would carry but very little thrust. Hence probably arose our designers' difficulty. If the diagonal would not resist the thrust, the upper chord, if stiff enough in its joints, would undergo bending moment, if not, the truss would fail. But all this is on the supposition that the live load of 7200 lbs. on the first vertical is the only weight. In any real case we have the constant steady load which produces a tension on this second diagonal. The additional weight at the first joint, by its tendency to produce compression in the second diagonal will reduce the tension by just the amount of the compression, still leaving the piece under tension.

We perhaps owe an apology to our readers for taking up so much space with this matter, but one of our reasons is, that it affords an example of the state of things which obtains in so many country bridge lettings; the officials who advertise for bids understand little or nothing of the principles of bridge designing, and are not able to discuss a strain sheet, to say nothing of the proper proportioning of the parts and details to resist these strains. They hear the specious arguments of the interested agents, and what wonder that they are completely bewildered. When they are d screet enough to call in a competent adviser, they probably get such a bridge as they want, but otherwise they get such structures as may be found in so many places throughout the United States. The general sentiment of the profession is in favor, we believe, of some legalized system of inspection and test, although there is not an entire agreement as to the best form which legislation on this matter should take. Such inspection is required in other countries, and, if we look out for the public safety by inspection of steamboat boilers, requirements as to life preservers and life saving appliances, building laws and restrictions it is certainly legitimate that the lives of the traveling public should be protected from the liabilities of bridges to break down owing to faulty designs.

It is far from our intention to include in our remarks those bridges designed and erected by our good companies, who care for their professional reputation, and those built for, or under the supervision of, engineers who, to use a plain phrase, understand their business. Such structures have caused the American method of bridge construction to be considered by foreign engineers well worthy of careful study; but we have too many slight and insecure affairs which are yet standing b cause they have not been subjected to the greatest possible load. Every few months we hear of one which has been brought to the test and found lacking.

LAKE SHORE PROTECTION.

At the November meeting of the Evanston Philosophical Association, Dr. H. M. Bannister, Editor of the Chicago Medical Review, read an interesting paper on the phenomena connected with the erosion of our lake shores and suggested a means for their protection. The essential ideas are worthy of preservation although we are not able to reproduce his essay in full. Dr. Bannister will be remembered as connected with the expedition to Alaska under the auspices of the Smithsonian Institute at the time of the Seward purchase and also as being connected with the geological survey of Illinois, in which he investigated and reported upon the geology of Cook and Lake counties.

Some years since, while engaged upon the geological survey of this state, I made a number of observations upon the erosion of the lake waves upon the shore from Chicago north to the state line, its rate, method, etc., which the scope and limits of the county reports made and published in the volumes of the survey did not permit me to record. These observations were made from a geological rather than an economical point of view; their bearings however in the latter direction were obvious and could not be ignored at the time. The high stage of water in Lake Michigan during the past season, and some remarks on the subject published in recent numbers of ENGINEERING NEWS, have recalled these observations and also other thoughts on the subject of lake shore protection which occurred to me at that time and have developed to some extent since. They apply more particularly to the low sandy shores from Grosse Point southward, though not altogether inapplicable to the higher shores to the northward. I have not, however, studied the subject as much in reference to the high clay bluffs where there are probably other factors in the wear not met with to the same extent as in the other sections. [Dr. Bannister, here spoke of the frost which probably was one of the largest factors operating to throw down the clay banks referred to above and which was quite absent in the sand and earth banks below.]

There are several things to be considered in studying the action of the lake waves upon the shores, which, though they have probably been noticed before, call for attention. The erosion of the banks is a much slower process at the present time than is perhaps generally supposed. It is very easy to obtain an exaggerated idea of its rate by observing the action of single storms at particular points, and ignoring the fact that everywhere else it may have been almost *nil* at the same time. The false estimate thus derived, has even found a place in scientific papers. Thus Prof. Andrews in his very interesting memoir on the N. American Lakes as Measures of Geological Time, has stated the rate of erosion at Evanston to be nearly seventeen feet a year, a rate, which, had it really existed during the twenty years that the shore line has been observed by me, would have carried it more than one hundred yards farther inland than it is at present and left no site for a number of public and private buildings such as the Gov't lighthouse and Dempster Hall. If Dr. Andrews' estimates for other localities were as much out of the way as that for Evanston, it would very seriously affect his argument as to the length of the post glacial period.

Undoubtedly the measures taken to protect the shore since the existence of the village have diminished the annual wear, but it is still safe to say that it never exceeded a mean fraction of Dr. Andrews' estimate at any time since the lake reached its present level. From shore marks which have been under my observation since 1856 I am confident that not over seventy-five feet of shore has been washed away since that date.

Surprising as this slow rate of erosion may appear when we consider only the force of the waves and the non-resistant character of the banks,—sand and gravel with a small proportion of clay,—it is easily accounted for when we remember that it is altogether due to a few fall and spring storms. In summer the action of the waves is often protection by adding to the width of the beach, in a manner which I shall try to describe farther on, and in winter the lake forms its own barrier in the ice hills it piles along its shores. Something, perhaps, should also be attributed to the comparative shallowness of this portion of the lake which prevents the waves from accumulating the same power as in some other localities.

On the western coast of Lake Michigan the most violent and destructive gales are from the northeast, and the drift is therefore to the southward. The waves strike the shore in these storms at an angle of about 45° and being reflected the result is a current of considerable rapidity and strength along the shore from north to south and a consequent travelling of the sand and shingle in the same direction.

This current during storms naturally scours out its own channel near shore but it does not prevent altogether an accumulation of material outside of it to seaward and the result is a sand bar which exists generally at from six to ten rods from the beach, and on which there is usually but three or four feet of water, while within there may be seven or eight feet. The shore face of this bar is usually quite steep while the seaward face is generally very gradual. This bar also assists in breaking the force of the waves, and to that extent protects the shore.

The tendency of the drift on this bar is constantly shoreward and, in seasons of long continued moderate weather when from non-occurrence of gales the undertow scarcely exists, it may even obliterate entirely the deep channel scoured out by the shore current, the result being a considerable addition to the width of the beach. Such a process has been in operation the past few seasons along the shore south of the Evanston pier, that locality no doubt being favored by the effect of that structure in breaking the force of the storm waves from the northeast. It may occur, however, to some extent, under various accidental circumstances almost at any point, and the reverse process is almost equally liable to take place under certain conditions of weather, etc.

Thus accretion or erosion of the beach is going on at all times, and the respective proportion of each of these actions seriously complicates the question of the rate of the annual wear of the bluffs or true shore line. With a narrow beach, or, as sometimes happens, with no beach at all, this action is rapid; it is slow or does not occur where it is wide, and either of these conditions may exist at different times at the same point of the shore. The only general rule that can be stated is that the contour of the shore has its influence;—the shore on projecting points is most liable to erosion, and that it is least so, and accretions are most likely to take place in bights or retreating curves of the shore. Our coast line here, however, presents so few angles or indentations that the effect of contour is but slight except, perhaps, on that very obtuse angle just north of Evanston known as Grosse Point. That is probably the most exposed point of the coast for many miles and it is included in the extent of shore of which I have observed the rate of erosion for the past twenty years.

From the foregoing it will be seen that the beach is a

material protection to the banks or bluffs, and the measures that have been employed along our shores for the prevention of erosion have generally been taken in recognition of this fact. They consist for the most part in the construction of groins or "sand catchers" pushed out at right angles to the shore for the purpose of stopping and collecting the drift of sand and shingle and the consequent widening of the beach. The effect of these dykes or groins is to divert the current in storms from the immediate shore and to lodge the sand on their windward side, thus extending the area of the beach and in so much protecting the bank or bluff. While they are, in the main, serviceable for the purpose for which they are designed, they still have some drawbacks which I will mention. In the first place, while they cause an accumulation of sand on their windward side, they seldom do as much on the other, and in very violent storms it frequently happens that the seas sweep entirely over them, and falling in cascades over their leeward faces, have an excavating action that washes away the beach and leaves the bank altogether exposed to gales from the opposite direction, which are not rare at certain seasons. This secondary action of these "sand catchers" has, I believe, been the cause of legal proceedings for damages in one or two instances, and when the stage of water is high, as at the present time, it may become of some importance.

In river channels similar structures are generally supposed to afford protection to an extent of shore some five times their own length. There the current alone has to be considered, and it may be stated to be, in general terms, parallel to the bank. On the lake shore, on the other hand, the storm waves strike the shore at various angles according to the direction of the wind, and the protection afforded by these groins may be, under certain circumstances, absolutely nothing. It not unfrequently happens that they afford a partial protection to only about their own length of shore. This with the fact that the protection they afford is mainly in one direction, makes a great many of them necessary. Their cost, as usually constructed, of parallel sided cribs of square timber, filled with stone and decked with plank, is about $4 or $5 per lineal foot; they are far from durable, require frequent repairs, are liable to damage from storms, from ice of winter, from wreck and driftwood, beside the gradual decay to which all wooden structures above water are subject. All these defects make a system of shore protection depending on these structures alone quite expensive. However, I think they will always form a part of any general plan that may ever be adopted. Alone they are expensive and inefficient, but in combination with other means they may assist in making an efficient, durable, and in the long run, a much cheaper system of shore protection than the one now in use.

To thoroughly protect the shore requires much more elaborate and expensive means than those commonly in use, and this is quite impracticable at any but a few points along our shore. A solid structure projecting a considerable distance into the lake, like the north pier at Chicago, will cause extensive accretion in its immediate vicinity, but its influence is exhausted at a comparatively short distance. The only method entirely permanent is to make the shore itself resistant to the waves by facing the bank with some material that will withstand their force. A solid timber facing, sheet piling or a sea wall may meet these requirements. The first of these is easily practicable and could hardly be more expensive than the building of a crib, breakwater, or groin every few rods as is now practiced in particularly exposed localities. Built in a similar style of solid squared timber, well bolted, with tie-pieces durably anchored behind, only one face would be necessary instead of two such faces in the form of a crib, with solid ends, cross-ties and bottom and deck, the whole filled with stone. When we consider that under some circumstances the crib only protects its own length of shore, the advantage of the timber shore facing constructed with not over one-half the material as to probable cost is sufficiently obvious. Such a construction, properly built, would probably serve its purpose twenty or thirty years before the natural decay of the wood would necessitate its renewal. The effectiveness and durability of this kind of protection is shown by the timber work around the old brick yard north of Grosse Point, which was built over twenty years ago, of rough round logs, and projecting beyond the beach, protects an area of made land. Though very loosely built, there being spaces of several inches between the logs, allowing the passage of waves to some extent, it still stands and has protected the greater portion of the enclosed land. A better constructed timber facing, placed well up on the beach would I think, be equally durable and efficient though built of only a small fraction of the material.

A still more permanent and sightly protection would be a sea wall of masonry. The expense of this, however, if built or even faced with stone, would be greater than that of any other method that could be reasonably employed, and if this were the only material to be used a sea wall might be regarded as impracticable in this region, at least at the present time and in competition with other means. It could be constructed, I think, of concrete in monolithic masonry at a comparatively light expense and in a manner to meet all the requirements of such a structure. Excepting the cement the materials for such a wall are to be had at almost any point on the beach, and the cost of the former with that of the labor and the necessary appliances for making the concrete and molding the wall would be all that would have to be met. There is ample precedent for the use of such concrete in such work.

A wall of this material erected against the face of the bluff would protect it against the undermining action of the waves, even if only three or four feet in height above the beach. Its foundation should be below low water mark. Without going into details, I will only add that as regards the wall itself, if erected in the early summer so as to have time to harden before being put to trial by the fall storms, I see no reason why it should not meet all the requirements of such a structure. It certainly would be the cheapest kind of sea wall for this region where suitable stone is wanting.

With any method of facing the banks, whether with masonry or with timber, it would still be advisable to have groins or "sand catchers" at intervals of a few hundred feet to divert the current from the immediate shore and preserve the beach. These, however, need not be of the expensive kind now in use. The "sand catcher" or breakwater, as it is here called, that has lasted longest on the shore at Evanston, is a rough, triangular one on the University shore, which was placed there in 1858. It consists of rough logs in the shape of a V, the apex out in the lake, bolted and tied by cross-pieces. This is now nearly past its usefulness, not being kept in repair of late years. A similar construction under the shore end of the Evanston pier, though built of loose logs and partially filled with brush in 1857 commenced gathering sand as soon as built, and is now nearly buried under the accumulations. These examples suggest ideas of cheaper, more durable and efficient contrivances than those now in use.

INTIMIDATION AT THE JETTIES.

An ominous silence broods over the mouth of the Mississippi. After reading reams of news for the past six weeks, only here and there a barren scrap have we met, in regard to the wonderful success of the great jetties. From the great commonwealth of Louisiana, "the land of cotton and the cane," tales of horror have met our eyes, until we believe whites, darkies, the state government, and northern visitors, are all alike fiends, and we are laying by our meagre salary as editor of ENGINEERING NEWS to purchase a brace of Colt's best N. R., in contemplation of our visit to New Orleans in April, to attend the annual meeting of the American Society of Engineers. Anarchy has settled down upon the state, until it ceases to perform its functions as a part of our common country, and we strongly suspect it pervades that great artery of commerce, the Mississippi River itself. The "Father of Waters" has apparently been "bull-dozed" and long ago refused to scour more for "Capt. Eads' jetties," and yet he and his co-laborers utter not a word of complaint. Have the Gov't engineers again "bull-dozed" them? Which is it? Even the New Orleans and St. Louis papers, as if taking their cue from the sullen river, have long since ceased to scour out a channel. Why this ominous silence?

We rejoice,—Why? Our political friends out on the street are shouting for Tilden or Hayes,—Which? To-day is a Tilden day, and the Tilden men shout for the triumph of what—their views we suppose, while the Hayes men are doggedly silent; yesterday it was a Hayes day and the reverse took place. In the mean time the country can go to smash, if it likes, provided one or the other party cabals succeeds. So with us; we rejoice that our views in regard to the jetties, expressed from time to time in this paper, have already been demonstrated, or are in a fair way to be demonstrated. We care not if our views intimidate the Mississippi River, and prevents it from performing its foreordained functions, as Capt. Eads practically asserted of the views of the Gov't engineers in June last. It is enough to know that the construction of the jetties have failed to demonstrate the views of Capt. Eads. It is enough to know that they have not demonstrated, at least in full, the views of the Gov't engineers. It is enough for us to know that they have largely demonstrated the views of that modest sheet, ENGINEERING NEWS. In the mean time the giant Mississippi, forcing its self-appointed hostlers to adopt constantly new devices to keep it within control, is solving the problem in its own way, always provided it is not "bull-dozed" by Capt. Ead's "traducers." The views we are about to express cannot be tortured into an opinion that the enterprise will not succeed, but success will rest on ideas not predicated in the beginning, either by Capt. Eads or the Gov't engineers.

The careful reader of the NEWS knows what our views are without a recapitulation at this point. As bearing on these views and confirmatory of them, we will give such information as we have been able to gather outside of *ex parte* sources.

We have at hand the report of Gen. Comstock of Sept. 20, and, although somewhat out of date, it makes up a valuable link in the history of this enterprise. At the mouth of South Pass, "little work has been done on either the east or west jetty since April 30th." A few additional mattresses have been added at low places. Piles driven near the sea end frequently disappear and are replaced by new ones.

"Thus on May 24, for a distance of 150 feet at end of west jetty all the piles but one disappeared, some of them having settled 5 feet in nine days. Twelve new piles were driven in the place of these, their heads being 8 feet out of water. In the following week they all had sunk so that their heads were under water. In the east jetty between 11,400 and 12,000 feet from East Point, the tops of the mattresses have settled 3 or 4 feet so as to be below the water-surface."

A few mattresses have been added to raise the jetties in low places and also to widen the east jetty near the end to 80 feet base. Details are given of the endeavor to produce artificial scour by means of rakes, etc., and of their failure. In his last report two pairs of spurs of piling, each about 150 feet in length had been driven between the jetties near the seaward end. Additional spurs have been driven making eight pairs in all. These spurs are opposite each other, starting from the inner side of the jetties and running towards the middle of the pass, and consist of 15 to 20 piles driven 8 to 10 ft. apart, with mattresses inclined against their upper side for the whole length of the spur. Frequent repairs are necessary and often individual spurs have been completely destroyed by the undermining action of the current or the force of the waves, and have been replaced.

"These spurs narrowed the free space for the passage of water from 950 to about 650 feet in width, and increased the velocity of the current;"

And farther on:—

"These spurs were completed early in June, and it would seem that the increase in depth at the mouth of the pass, since April 30, has been due mainly to them,"

A table is given showing the draught that could be carried through the pass in

August, 1876: 0—2000—23.5; 2000—4000—19.6; 4000—6000—21.0; 6000—8000—23.5; 8000—10000—23.0; 10000—12500—19.8.

We publish these figures as they convey a different impression from those published at that time from other sources. The result of soundings taken Sept. 11 and 12 by Capt. Eads published in our paper of Sept. 30, show a very radical improvement at that date. That the bottom fluctuates greatly is shown by the following:

"The bottom, near the sea ends of the jetties, is quite changeable. On June 23, the distance on the axis of the pass, from the 20 feet curve inside, to the 20 feet curve outside was only 100 feet. On July 9, it had increased to 800 feet."

"The destruction and rebuilding of spur-dams Nos. 13 and 14 may have had some influence in this change."

Since May there has been little change down to the 6000 ft. point, but below the depth has increased in the different sections "by amounts ranging between 2.5 and

5.9 ft," due no doubt to the water-way, "now diminished at six points from 950 to 650 feet in width by spur-dams projecting from the main jetties." The 20 and 30 feet curves have changed but little as a whole. Sections carried out in the line of the jetties "as a rule indicate a filling on the lines of the sections."

"But little work has been done at the head of passes, that work having been mainly confined to the erection of a dam, running from the head of the island to the main jetty, closing the East entrance to the South pass, and the commencement of a second dam about 1600 feet above the first and nearly parallel to it. There has been no important changes in the shoal at the head of the pass. Grand and Picayune Bayous have been closed."

These dams are made by driving piles 8 or 10 ft. apart in rows, against which mattresses are inclined on the up stream side. They often give away or are undermined by the current and require frequent renewals.

"Excluding the crews of boats and the men getting out willows, but a small force has been employed during the last three months, sometimes not more than 15 or 20 men."

We hope that the entire force has not been removed during the late excitement.

Since this report was written we have learned that Capt. Eads has put across the head of Southwest Pass a sill of matresses to prevent the pass from enlarging in consequence of the volumes of water turned from South Pass by the works designed to confine the current in scouring out the channel.

Later still we learn that the bar at the head of South Pass is exceedingly hard and that a dipper dredge is at work on it with such great success that two more have been ordered and are probably ere this actually employed. Dredging is an exceedingly old fashioned way of scouring out the channel, but we have not the slightest doubt that, with ample time this method will meet with gratifying success. It is certainly a most excellent *dernier ressort*. The word *dredge*, a synonym of *scour*, illustrates well the wonderful flexibility of the English language.

When the channel is once properly eroded, scoured, or dredged, we have no doubt of the ability of the river to maintain it with proper auxiliary works. As we regard speed as an essential requisite to success, we would respectfully suggest that one of Newton's Hydraulic Dredges be employed, as it would, according to the figures submitted in our issue of Nov. 18, excavate a channel through the head of the passes 500 ft. wide and 30 ft. deep in 30 days.

In the meantime we shall hurrah for the success of the jetties when they succeed, for "nothing succeeds like success." If Congress can be persuaded to abstract its mind from the important question of President making for a few moments, we hope they will give this a little attention and donate that first installment quickly, as we should like to see more activity at South Pass either by Capt. Eads or the Mississippi river. We hope a committee will be sent down to inquire as to whether the river has been intimidated or not. We shou d like to know.

BY way of variety we have changed the heading to our paper; we hope it may not prove unacceptable to our readers.

WE notice that a direct stroke Worthington Duplex pumping engine was shipped from New York to Rock Island for the Rock Island Waterworks, on the 22d ult. These pumps are very cheap and give excellent satisfaction wherever used both as regards duty, which is unusually high, and repairs. The one for Rock Island occupies a space 4 ft. by 10 ft. on its bed, has 20 in. steam cylinders and 12 in. pump cylinders and a capaci ty of 2,000,000 gallons per 24 hours. The cost of the pump, exclusive of suction pipe, discharge pipe or any connections was $2,740. This, with the pumps now in use at Rock Island, will give a supply of 6,000,000 gallons per day, when all are in operation.

THE Centennial Exhibition buildings were sold on Dec. 1, at a great sacrifice, due in part no doubt to the fact that the sale was not extensively advertised. Buildings costing in the aggregate $2,278,228 were auctioned off at $282,375. Many smaller buildings were sold of which we have not the figures. Among the sales we notice the main exhibition building, costing $1,600,000, sold for $250,000, and the judges pavillion costing $30,000, sold for $1,000; both to I. S. Morton for the permanent Exhibition Co. The Corliss Boiler House costing $20,976 was sold for $1,500 to John Welsch for the Franklin Inst. The art gallery annex costing $110,000 sold for $3,050 to local parties. Agricultural Hall, costing $270,000 was sold to its builder R. J. Dobbin for $13,100—other buildings were also bought in by Mr. Dobbin for speculative purposes. Some of the smaller buildings were bough up by private parties from a distance to be removed for summer houses, etc., but most of the buildings were sold to local parties at nominal figures. We understand the Gov't building is to be removed to Washington for a permanent exhibition.

WE present to-day a paper on Lake Shore Protection. This subject is every year becoming of greater importance to our cities and towns situated along water fronts, and even now the capital invested in conserving our shores aggregates an enormous sum. As we remarked in our issue of Nov. 11th, no cheap and efficient plan had yet been presented, all means of that character having thus far signally failed; and it is with the hopes of calling out papers from other parties who have long observed the phenomena connected with the erosion of our shores; and have been called upon to exercise their skill with greater or less success in their protection that we publish this paper. Of the method presented we do not feel called upon to criticise at present. There are, however, persons connected with the *Engineering Club*, as the Illinois Central Engineers, and also the Gov't Engineers, who have had extensive experience in the solution of this problem, and who, if they have no adequate solution to offer, can at least present the difficulties to be mastered in a comprehensive manner. From all whose position has given them the opportunity of studying this problem we solicit communications or formal articles for publication.

IS THERE ANY ECONOMY IN CONTINUOUS GIRDERS?

So much attention has of late been given to the application of the principle of continuous girders to bridge construction, that I feel at liberty to offer my mite toward the general fund of information on the subject.

The theoretical portion thereof has been fully and ably treated by Chas. Bender, C. E., and Professors Du Bois, Greene and Merriman. My office is merely to recount an attempt to apply their work.

Having occasion (shortly after the appearance of Mr. Merriman's paper in Van Nostrand) to compete for four continuous spans of Iron Truss bridging, it seemed a fortunate opportunity to test the theory and avail oneself of the economy in material, if such there was.

The bridge was for highway, in spans of 135 ft. each. The specifications required the trusses to be capable of carrying a moving load of 1600 lbs. per lineal foot with a factor of 6 for safety.

To compare the systems, four double intersection Pratt trusses of nine panels each and having a depth of 22 feet between centres, were figured. Also a continuous girder of same depth and like number of panels in each span. The style of bracing, however, being single intersection Pratt truss. This latter circumstance was somewhat in favor of the continuous girder, the single system of bracing requiring slightly less material than the double in so short a span.

The independent trusses were designed with ends battered, as were the ends of the continuous girder at the abutments.

In the continuous girder, every effort was made to so construct the members alternately affected by tensile and compressive strains, that they might contain as small a percentage of waste material as possible; even at the cost of efficiency.

The top chords were composed of channel and plates, the channels breaking joints at panel points and the plates in centre of panels, the whole area being considered effective against tensile strain, less the area of two rivet holes.

The bottom chords were composed of eye bars 4 in. deep, those near the pier having 9 and 10 inch channel bars riveted between them, others subject to less compressive strain were simply joined together in pairs by light zig-zag trussing, in any case only one rivet hole being deducted from the effective tensile area of any bar.

The continuous girder was arranged to be secured to centre pier and to rest on rocker bearings on the other piers and abutments, this method materially reducing the weight of cast iron in pedestals or bridge seats.

The strains were worked out and members proportioned thereto for spans 1 and 2. Spans 3 and 4 would of course be similar in all particulars. The maximum strains were deduced from four systems of loading, viz.:

1st. Total uniform load.
2nd. Span 3 loaded, spans 1 and 2 unloaded.
3rd. " 2 " " 1, 3 and 4, "
4th. " 1 " " 2, 3 and 4. "

Counter strains determined by moving live load panel by panel, over the spans under consideration.

The result, (without the floor system which would be the same in both) are given below.

Weight of material in spans No. 1 and 2, continuous girder:

Chords,	–	28505	lbs. of	wrought iron.
Lateral system,		6890	"	" "
Cast connections,		1614	"	" "
Web system,		43140	"	" "
Total,		80149	"	" "

This being divided by 270 the length in feet of the two spans, gives 296.85-100 lbs. per lin. foot.

Weight of material in two spans of the disconnected Pratt Trusses:

Chords,	–	33792	lbs. of	wrought iron.
Lateral system,		6730	"	" "
Cast connections,		3300	"	" "
Web system,		36200	"	" "
Total,		80122	"	" "

This amount divided by length of the two spans as before, 270 feet, gives 296.75-100 lbs. per lin. ft. The above figures seem to prove conclusively Mr. Chas. Bender's theoretical deductions. The continuous trusses show a slight saving of weight in the chords, which is more than counter-balanced by excess of material in the web. Again the extra amount of labor on the continuous girder necessary to render members capable of carrying both tensile and compressive strains, falls but little short of ¼c per lb. on total weight of structure.

In short the showing is not at all favorable to the continuous method, leaving out of consideration the one great and undisputed evil of continuity, that the loss of one span involves that of adjoining ones.

I admit that the condition on which the above estimates are based, (equal and moderate spans) are not according to Messrs. Du Bois and Merriman, the most favorable to the continuous girder. But I submit that under the conditions there should have been some slight showing in favor of the principle of continuity, if the tenth of a pound per foot had been on the right side, it might have been some consolation to the friends of the theory. Furthermore, any system that required the spans to be especially adapted to it, can be of but limited utility. The tediousness of, and time required to make the calculations is another practical objection, although considered immaterial from the professor's stand point. The desire that something over two days time spent on the above estimates shall not be utterly lost, prompts the writing of this article, and if it prevents a like waste of time by any other member of a profession, who in general have but little time to lose, I shall feel amply repaid.

J. A. PATTERSON, C. E.

The Wire for the East River Bridge.

The *Iron Trade Circular*, one of our English exchanges, says:

"Some of the English newspapers are never tired of repeating, without the slightest qualification or explanation of the special circumstances surrounding the supposed fact, that the Americans still continue to push their wares into this country; that such goods—and especially hardware manufactures—are competing with our own productions in our own hardware districts, in deed, at our very doors; and that such goods 'are by some customers declared to be rather superior than inferior' to those produced in our own workshops and factories. These constantly reiterated stories, however, must needs be taken with the proverbial grain of salt. The fact that tenders for supplying 3,400 tons of galvanized steel cable wire, for the erection of a suspension bridge across the East River, between Brooklyn city and New York, had been advertised in the English

newspapers, seemed to buoy up the hopes of certain manufacturers on this side the water that the reported improvement in the United States trade was at length stimulating in a very legitimate fashion American business with the old country; and we were gravely told that such an application had never reached England from American consumers for a long time past. It is no doubt perfectly true that tenders have been invited here for the supply of this large quantity of steel wire for making the cables for the permanent suspension bridge just referred to; but it is also true that the two cables at present extending from New York to Brooklyn are formed of best English patent steel plow wire, the special manufacture of a Warrington firm of the highest repute. These last named cables, be it remembered, are only for the temporary bridge, which will require in all probability about 150 tons, the bulk of which will be made in American wire mills. It is well to remember, too, that the specifications for this thirty-four hundred tons of wire were drawn by an experienced engineer, who has had every assistance from his brothers—gentlemen who are thorough practical wire drawers and cable manufacturers.

"For these reasons we can well understand how the specifications in question came to be worded so stringently as to place them beyond the reach of English competition. What then are the facts? In the first place the wire must be made from the best cast crucible steel (no Siemens Martin nor Bessemer will be accepted), hardened and tempered, and must, after galvanizing, stand a breaking strain of 90 tons to the inch, and be drawn in pieces of not less than *sixty* pounds, and to be delivered at the rate of 200 tons per month should the committee require it. Well, now, there are only two wire firms in England who can make this specific article —one, in the neighborhood of Birmingham, famous for the production of homogeneous wire for ocean cable purposes; and the other a no less celebrated maker of patent steel wire in Lancashire. Of this the engineer who drew the specifications could not be wholly ignorant, since it was well known that these firms were not disposed to sacrifice their regular customers for the time being for the sake of this tempting order. So it is not uncharitable to look upon the whole affair as a 'bogus contract,' for we have the assurance, almost amounting to certainty, that not only the wire but the steel wire will be made in America. If we are correctly informed, overtures have been made to at least one English firm by American wire manufacturers to go over there with a competent staff in order to put Yankee workmen in the way of hardening and tempering wire by a patent process; and as considerable inducements were held out to this end, in simple consideration of this large order, it follows that the 'cute Yankees knew pretty well where the contract would be placed. It may be that the wire for the cables upon which there will be the greatest strain will after all be obtained from one of the English wire mills, to which reference has been made; but, unless probabilities belie the situation, a large wire company at Worcester, Massachusetts, will get the lion's share of the contract. Nominally, the contract is an 'open one,' but really it is open to no firm or individual who has the temerity to attempt to take orders except through certain well-defined channels."

Land and Mineral Decisions.

Copp's *Land Owner* for November reports a decision by the Secretary of the Interior in effect as follows:

"The filing of a declaration of a pre emption statement before settlement does not invalidate a right in absence of an adverse claim. All *ex parte* evidence filed after the close of the hearing in a contested land case, before the local land officers, must be rejected except as a basis for an application for a new hearing. All documents, all exhibits, filed in the case when the same have passed beyond the jurisdiction of the General Land Office, must be passed upon by the department proper, and no paper thus filed should be referred by the General Land Office.

In school grants, where a party settled on land in the sixteenth or thirty-sixth section, long prior to the survey thereof, but has exhausted his pre-emption privilege, he cannot by a homestead entry prevent the tract from passing under the school grant.

Regarding swamp lands, it says that to settle upon lands of a swampy character would raise such a doubt of the settler's good faith as, upon a proper application, to justify an order for an investigation. At such a hearing the character of the land at the date of the settlement should be determined. When notice of the selection of a tract by the State is received at the local Land Office, the State should be notified before proof and payment is made by the settler thereon. But where patents have been issued under the form ruling of the interior department, cases will be considered *res judicata.*

Timber culture.—Land covered by an invalid State section may be entered under the provisions of the Timber Culture Act, or otherwise subject thereto.

Decisions by the Commissioner of the Land Office are reported as follows:

Town sites and mining claims.—The fact that a given tract of land has been entered or patented as a town site in no way prevents the owner of the lode or claim to secure a patent to his mine. It is sometimes excluded from the operation of such a town site patent, as in the case of a placer claim when the surface of the ground is absolutely necessary to the successful working of the mine. It cannot be included in a town site entry, or a patent of the Comstock lode mines, and Sutro tunnel. In cases of applications for patents for mines on the Comstock lode, Nevada, hearings may be had to determine whether the mines in question have been benefited or drained by the Sutro tunnel, but the Commissioner of the General Land Office will not attempt to intefere with the right of mine owners to exercise control and ownership over their mines, so long as they comply with the requirements of the law."

Fall River Pumping Engines.

The pumping engine, built by Henry R. Worthington, Esq., in 1875, for the Fall River Water Works, was subjected on Wednesday, Oct. 4th, to a thorough test to ascertain whether it was capable of performing the duty guaranteed by the builder. Two things were guaranteed by Mr. Worthington: Frst, that the engine should be capable of pumping 5,000,000 gallons in 24 house to a height of 200 feet. Secondly, that the engine should show a "duty" of 65,000,000; that is, should be capable of raising 65,000,000 pounds of water one foot high with 100 pound of coal.

The engine had previously been tested with reference to the first requirement, and had exceeded the capacity of 5,500,000 gallons in 24 hours. The test last Wednesday was with reference to the second requirement, that of "duty."

The test was conducted by Mr. F. W. Jenkins, principal assistant of the Worthington Hydraulic Works; Capt. D. H. Johnson, formerly Superintendent of the Salem Water Works, now agent for the Worthington engines, and the Chief Engineer and assistants of the Fall River Water Works.

Mr. F. A. Andrews, engineer of the pumping station in Natick, was present and had charge of the boilers during the experiment, and much of the success of the trial was due to his skilful management of this department. The results of the trial are summarized below:

Trial began at 9.30 a. m.; ended at 10.30 p. m.
Total number of strokes, 31,376.
Average number per minute, 40.23.
Average length of stroke, 49.7 inches.
Capacity of pump per stroke, 82.3 gallons.
Total amount of water pumped, 2,582,245 gallons, or 22,535,932 pounds.
Total lift, including friction in force main, 217.52 feet.
Total weight of coal burned, 6,600 pounds.
Duty, 70,907,177, showing an excess of 9 per cent. above the guarantee.

This result, as well as the substantial and thorough manner in which the engine is constructed, reflects great credit on the ability and honesty with which Mr. Worthington has fulfilled his contract, and the city is fortunate in the possession of a pumping engine that has proved so satisfactory in every respect.

NOTES.

A memoir of the late Sir W. Fairbairn, the distinguished mechanical engineer, is soon to be published.

Operations on the Sudbury river conduit of the Boston Water Works have been suspended for the winter.

One of the essayists at the recent Social Science Congress at Liverpool is reported to have made the strange assertion that sanitary engineers were a curse to the country.

With the late rains and the increased flow of water over the Croton dam, one source of anxiety to New Yorkers has dried up, and the papers have dropped all mention of the water famine that threatened so lately.

Gage & Son's machine shop in Waterford is being driven to its utmost capacity in the building of steam engines for the Ransom patent steam street cars. Several are in process of construction. One was completed and shipped lately to Philadelphia.

The number of vessels which have passed through the Suez canal the present year has been about the same as the previous year, but the tonnage averaging a little heavier the receipts have been somewhat larger. The stockholders may therefore look for a dividend again.

The Bay State Transportion League gives notice of intention to petition the Massachusetts Legislature for the incorporation of the Boston & Chicago Railroad Trust Company, with a capital of $35,000,000, with authority to purchase the roads to the New York line, and lease roads beyond so as to form a consolidated line to Lake Ontario and the West.

A meeting of those interested in the proposed railroad from Spencer to East Brookfield, Mass., was held at Spencer on Dec. 5th. Maps and plans of the road, and also plans of the Worcester County Central, Southbridge & Brookfield, and the proposed line from Brookfield to Rockville, Conn., which will form a part of the Worcester and Hartford line, were presented for examination.

At a test of the Logansport Water Works on Tuesday Dec. 5th, 8 one inch streams were thrown at one time, the highest thrown 120 feet. A slight change will be made in the furnace before the machinery will be accepted, after which a formal opening will be had. Logansport boasts of the most efficient and economical works in the State, being run by water power and having engines only as auxiliary.

From the report of Mr. Frederick Graff, the Chief Engineer of the Centennial Water Supply, the amount of water furnished by the works put up by the Board of Finance was 383,865,457 United States gallons. There are two pumps, one of a capacity of 6,000,000 gallons per day, and the other 1,000,000 per day of twenty-four hours each. These were put up by Henry R. Worthington, of New York, free of cost. From May 10 to July 10 the works were only run ten hours per day, during exhibition hours, the supply at night being obtained from the city works. These engines are still at work.

The Welland Canal improvement is being pushed forward with considerable energy by the Canadian authorities. The masonry was advanced a good deal further during the past summer than was anticipated last spring. It is the opinion of those employed on the work that all the masonry will be completed between sections one and twelve, inclusive, next summer. All the locks, bridges, etc., are in progress at present The Great Western tunnel, which will take about 30,000 yards of masonry, was started this fall and has been advanced with wonderful rapidity to the fourth course, the full length of the tunnel. On the old canal a good deal of dredging has been going on all summer, but it will require two or three summers more to complete the work of widening and deepening the old cut to correspond with the new.

Contractors' Intelligence.

By January 1, $290 000 of the $150,000 appropriation for the erection of the new Insane Asylum at Indianapolis, Ind., will have been expended, and it is estimated that it will take another $350,000 appropriation to finish the building.

The Missouri Valley Bridge Company of Leavenworth, Kansas, were recently awarded contracts, by the Board of Commissioners of Atchison county, for the construction of three iron bridges, arch plan, one being of 75 feet span and two of 50 feet each.

The Kellogg Bridge Company has the contract for rebuilding the portion of the Louisiana Bridge recently destroyed by the washing out of the pier and dropping two 157 ft. spans into the river. The contract calls for one span 320 feet long over all.

THE ECONOMY OF CONTINUOUS GIRDERS.

In the articles which have recently appeared in *Van Nostrand's Engineering Magazine*, both sides of this subject have been ably discussed, and the writers seem to agree on one point, the desirability of having a crucial test of the truth of the claim that continuous girders are more economical of material and less expensive to build,—two things which are not by any means the same thing. One writer says,— in regard to the question whether it is expedient to construct continuous bridges, and, if so, whether they are more economical than single spans,—"that this question is not yet decided, and that it cannot be settled by theory, but only by actual trial; and since common sense, founded on experience, teaches us that a long continuous beam is better than several short single ones, and since the theory of flexure (often verified by experiment, and accepted by all scientists as a good working theory) indicates a large saving by the use of the continuous truss, that therefore it is well worth the while now and then to try." The other writer desires the particulars of one executed continuous bridge that is lighter than equally strong single spans, or working drawings and computations for such a continuous girder, so that the quantities may be checked, to see "whether such a bridge is properly designed, and whether it is lighter than we can design bridges, whose calculation is only based on the plain law of the lever." He also goes into the question of economy in first cost and erection.

The contribution in our last issue is therefore very welcome as giving the results obtained by the engineer of a bridge firm, working on a competitive design, and naturally desiring to make the most economical structure. As almost all of our bridges are designed and erected by bridge companies, with their own choice of type, under certain restrictions as to span, load, etc., their engineers will naturally tender on such designs as their figures prove will be the cheapest for them to build; it is therefore asking too much to desire them to tender for a continuous truss when their strain sheets and cross-sections call for a larger outlay in dollars and cents, if others are free to offer single span designs. Engineers will only be too ready to build continuous girders, if they can be made to see a saving of *money* in their figures.

We shall therefore be glad if any one is prepared to show wherein our correspondent has erred in his computations or results. We will only make, at this time, one or two suggestions, in reference to the communication in question. It was necessary to use the single intersection system for the continuous girder, as, with a double intersection, the distribution of the shear between the two ties which run on each side, to the top of the pier post is indeterminate.

We question whether the distribution, as given, of the live load was such as to produce the greatest strains in all parts of the trusses. But it is quite possible that the writer, when he states that a certain span was loaded, did not mean that it was necessarily entirely loaded. The stresses in the chords of a continuous girder are not in all parts a maximum when the entire span is loaded, but will be greater under a certain partial load. However, such stresses would call for an increase of sections, and would therefore make the showing for the continuous system more unfavorable.

If such a partial load was found to change the points of contra-flexure over a greater length of either chord, by so much the more would the cost of construction be increased, in adapting that portion of the chords to resist both tension and compression. As we have not, however, made any computations or diagrams of our own, we cannot speak with accuracy; for the relative value of live and steady load, with the length of span, are disturbing elements.

The point of increased *cost of work* upon the iron is well taken. It is a quantity which does not appear in theoretical equations, and is one which may often be sufficient to reverse mathematical results as to economy. Any one who simply adds together quantities of stress from the strain sheets, and considers that truss most economical which gives the smallest totals, may err very much in his judgement.

Our columns are open to any facts or intelligent discussion which will lead to a settlement of this interesting question.

THE RELATIONSHIP OF STRUCTURE, DENSITY, AND CHEMICAL COMPOSITION IN STEEL.

An abstract of a paper read at the Buffalo Meeting of the American Association for the advancement of Science.

BY JOHN W. LANGLEY.

The attention of engineers and chemists has been directed within recent years to the question of how far changes of chemical composition in iron, steel, and certain alloys, produce variations in the hardness, elasticity and other so called mechanical properties of the metals most used for constructive purposes. Does the presence of minute amounts of material other than iron cause a sensible alteration in the qualities of steel and cast iron; if so, what are these matters and within what limits will the chemical structure of the metal induce changes of mechanical character large enough to be of practical importance? These and kindred queries relate to subjects of great prominence in an industrial point of view, and indeed complete answers to them would render the problem of how a piece of iron or steel would behave under given conditions of stress or temperature capable of an almost mathematical exactness of solution. The facts communicated in the following paper must be regarded as offering a slight contribution only, to this extensive subject.

In 1874 Messrs. Miller, Metcalf and Parkin of Pittsburgh, in connection with the writer, commenced an examination of the different *tempers* of cast steel; by temper is meant that condition of the metal which is conferred upon it in the melting pot and which determines its suitability for particular purposes, as for example, whether it will be best fitted for cutlery, or drills and picks, or for wire, or boiler plate. This temper, or condition, it will retain through all subsequent processes of manufacture and it is analogous to the difference between dissimilar metals as copper and zinc, or tin and lead, but not to the different states of hardness, or tempering, produced by plunging hot steel into cold water, which is transitory merely and is destroyed by heating.

Eight ingots representing as many tempers or grades were selected by the eye from the appearance of their fracture only; they were numbered in order from one to eight and then analyzed, the result being that the carbon decreased regularly from No. 1 to No. 8 while the iron increased with like uniformity, the other bodies present, silicon, phosphorus, and sulphur not following any uniform law. In March, 1875, or more than a year later, twelve ingots were chosen by ocular inspection and analyzed with the results shown in the following table, where the first column gives the numbers stamped on the ingots and the remaining columns the percentage composition of the steel:

TABLE I.

Ingot Nos.	Iron by difference.	Carbon.	Difference.	Silicon.	Sulphur.	Phosphorous
1	99.614	.302	....	.010	Less than .02 in every specimen	.047
2	99.454	.490	.188	.034		.005
3	99.373	.539	.039	.043		.047
4	99.270	.659	.120	.039		.033
5	99.119	.801	.152	.089		.035
6	99.085	.841	.040	.039		.024
7	99.044	.867	.026	.057		.014
8	99.040	.871	.004	.053		.024
9	98.900	.955	.084	.059		.070
10	98.860	1.005	.050	.085		.034
11	98.752	1.058	.053	.120		.064
12	98.834	1.079	.021	.039		.044
			Mean difference, .0647			

From an inspection of the above table it will be seen that the grade of the metal is determined by the relative proportions of carbon and iron only, and that a mean difference of sixty-four thousandths of one per cent. of carbon impresses such a change on the crystalline character of the steel that a trained eye can detect it by the appearance of the fracture; of course if a very impure material like pig metal were under consideration it is probable that the large amounts of silicon and phosphorus which it contains would affect its quality, but in good cast steel it is the carbon and iron only which are the influential constituents.

The general fact that steel, as selected by the eye, bore some relation to its content in carbon has been long known but it is believed that the above analyses prove this connection to be a much closer one than had before been supposed, and they also show that the crystalline character of the metal is altered by these trifling variations of composition to an extent having a direct bearing on its use for mechanical purposes.

Another object of inquiry has been to ascertain whether the composition of steel affected its density to the same extent that has just been shown to be true of its crystalline character. For this purpose it was necessary to avoid complicating the influence of varying percentages of carbon with the mechanical alterations produced by forging and rolling; accordingly after the ingots had cooled from the operation of casting, and before they had been reheated or hammered, would be the proper condition in which to take their specific gravities. A crown drill was used having an internal bore of a half inch; this was sunk into the body of the ingot on one side near that end which had been the lowest in casting so as to avoid the influence of *piping*, and the core then broken off by a wedge, thus yielding a smooth cylinder of three fourths of an inch in length and a half inch in diameter. The specific gravity of these samples was then taken with great care and the results reduced to the temperature of 60° Fahr. They will be found in the second column of the table below.

When steel of the grade used for cutting tools, known technically as high steel, is heated sufficiently hot and then plunged into water it acquires, as every one knows, increased hardness and brittleness; now workmen are well aware that if the metal is heated too much before plunging, the result is an extreme hardness but at the same time the brittleness becomes nearly equal to that of glass, and moreover the steel is permanently injured and cannot be restored to its original tenacity and ductility by forging. Steel so treated is said to be burned, and, as a general rule, any temperature above a cherry red heat will bring about this deleterious change. To ascertain the physical explanation of this fact the following experiments were tried. Round bars of three fourths inch diameter were rolled from the above mentioned ingots and nicked with a chisel at distances one inch apart. These spaces may be denoted by *a*, *b*, *c*, *d*, *e*, and *f*; the bars were then heated in such a manner that the end "a" was at a bright yellow heat, and the other "*f*" was black, that is, not visibly heated; it was then plunged in water and the pieces broken off at the marks made by the chisel. Thus there were obtained six one-inch cylinders from each bar representing portions of metal alike in every respect except the temperatures to which they had been heated, *a*, being at a full yellow and badly burned, *d*, being at a cherry red, the normal heat for proper hardening, and *f*, in nearly the state it left the rolls.

In the accompanying table the first column gives the ingot numbers, the second column the specific gravities of the pieces obtained by the crown drill, and the remaining ones those of the bars hardened in water.

TABLE II.

Ingot Nos.	Sp. gr. Ingots.	Heated Bars.					
		a	*b*	*c*	*d*	*e*	*f*
1	7.855						
2	7.841						
3	7.836	7.813	7.814	7.823	7.826	7.831	7.844
4	7.869	7.791	7.811	7.830	7.849	7.866	7.824
5	7.858						
6	7.844	7.789	7.784	7.789	7.808	7.812	7.849
7	7.819						
8	7.818	7.754	7.755	7.758	7.773	7.790	7.845
9	7.813						
10	7.807	7.744	7.749	7.755	7.769	7.812	7.836
11	7.803						
12	7.805	7.690	7.741	7.769	7.798	7.811	7.845

An inspection of this table will show that the specific gravity of ingot metal decreases as the quantity of carbon increases, the only exception to this rule being No. 11 which contains an abnormal quantity of silicon as shown in Table I. If the specific gravities in column *f*, are compared with the ingot column it will be seen that the former are higher than the latter, and as the samples marked *f*, were in the state in which the metal left the rolls this proves that an increased density is conferred by *hot* hammering and rolling, in the case of cast steel as it has long been known to do in wrought iron. The effect of the heating and sudden cooling has been to expand the metal, thus reducing its density nearly in proportion to its temperature, for the horizontal rows of figures decrease in a general sense from *f*, to *a*, and finally this decrease is seen to be uniform in ingots, 12, 10 and 8, which are those high in carbon, and to depart from uniformity in the ingots poor in carbon; the difference of specific gravities between heated and unheated steel is also affected by the quantity of carbon, for in No. 3 the difference between *a*, and *f*, is .031; No. 4, .033; No. 6, .040; No. 8, .073; No. 10, .082 and

No. 12, .135. Now the steels in the above table from 1 to 6 are so mild that they cannot be injured by a heat much short of whiteness, while those from 8 to 12 cannot bear more than a cherry red. The effect of burning is then to produce, among other things, an extreme expansion of the metal which renders the grain open, granular, and brittle; The fracture of the steel corresponding to the above letters is very characteristic and agrees with the indications furnished by the specific gravities, those of *a*, and *b*, or the burned specimens, in the more highly carbonized steel are brilliant and sandy, those of *d*, or cherry red heat, are glossy and silky, while *f*, is gray and fibrous. In conclusion, it would appear from these experiments that good cast steel consists essentially of an alloy or compound of iron and carbon only, and that it is not materially affected by quantities of silicon and phosphorus which do not exceed nine hundredths of one per cent, also that variations of less than one tenth of one per cent of carbon can be distinguished by inspection of a fresh fracture in an ingot, and finally *that when the engineer knows what proportion of carbon and iron exist in any metal suitable for a given purpose he has the power of so framing his specifications as to denote with great accuracy which one of the hundreds of mixtures called steel he wishes.*

Final Report on the Fox and Wisconsin River Improvement, by Gen. G. K. Warren, Maj. of Engrs. U. S. A.

To Gen. Warren we are indebted for this most interesting and valuable report. Familiar with the exhaustive character of his reports and the valuable scientific deductions which he always weaves in with the practical recommendations, and which are of high scientific value apart from the recommendations to which they lead, we anticipated its perusal with keen interest and confess we were not disappointed.

The Fox and Wisconsin route forms part of the Northern Transportation Route between the interior and seaboard recommended by the Windom Committee in 1874, and is of paramount interest to the three north western states,—Wisconsin, Iowa, and Minnesota. At a comparatively early date, 1848, its improvement was undertaken by the state of Wisconsin, who surrendered the works to a company in 1853. This company having failed to perform its agreement, its franchise was surrendered to a second company in 1866. In this year Congress took an active interest in the route, making the necessary appropriations for exhaustive surveys, and Gen. Warren was assigned to the department of the Northwest with headquarters at St. Paul, where he remained until 1874, the surveys and improvements being under his charge for the time. In 1872 the final transfer of all works, etc., was made to the U. S. Government.

In our issue of Aug. 19, a history of the various improvements is given, and a description of the wing dam system now under trial, so we shall not enter upon that subject at length. We shall merely follow Gen. Warren through his report, touching upon such points as will give an idea of its scope and of the measures proposed for improvement, referring the interested reader to the report itself for further information.

The report consists of 114 pages divided into five chapters, accompanied by 10 plates or maps of the river, and several page illustrations. The first chapter gives an abstract of the duties assigned him in this department, the various commissions on which he has served, all of which have conspired to delay the studies for the final report, dated Nov. 26, 1875, and made from Newport, R. I., a year and a half after leaving St. Paul. This chapter also gives a history of the progress made in the several years while in charge, and of the various reports made from time to time. All in all the General's plea of overwork is well taken, and an equal amount of work by any civil engineer at the present time, we venture to say, would resulted in a competence or "retiring fund."

In the second chapter is given the earliest historical accounts of the route; the near approach of the two rivers (1¼ miles) and the low portage made it the natural route of the aborigines in their travels and the path of early exploration. Sieur. Nicolet discovered the portage in 1639; Father Marquette and Joliet passed down the river in 1673, thence down the *Michi-Sipi* (literally "great water") as far as Arkansas, returning by the Illinois river and the portage near the present site of Chicago. Father Hennepin descended the Illinois River to its mouth in 1680-81, was captured by the Dakotas and carried up the Mississippi above the falls of St. Anthony, (which he named) to Mille Lacs, where he was ransomed by Lieut. Du Luth, and returned with him by the Wisconsin and Fox rivers. The history is followed through the English occupation to the U. S. occupation in 1783. "The village of Prairie du Chien when visited by Jonathan Carver in 1766, was estimated by him to contain 300 families. A remnant of this village, as distinct as the aborigines from the inhabitants of the American City, still occupies the old village site." Reference is made to the expedition of Lieut. Pike toward the source of the Mississippi in 1805; and the report of Maj. Long, Topographical engineer, on the Wisconsin river, in 1817 and again in 1823; the voyage of Capt. Whiting from Ft. Howard (opposite Green Bay) to Prarie du Chien, with a regiment in 1819 and his map of the route,—the history being brought down to 18 6, the time of the survey under the War Dept., by Mr. Center, C. E. This chapter is accompanied by an interesting map, a fac-simile of the autograph map drawn by Father Marquette.

Chapter III, gives a history of the various surveys and improvements from 1836 to 1870. Following the surveys of Mr. Center in 1836, we have the surveys of Mr. Petival in 1837, of Capt. Cram in 1839, and his report of 1845, the surveys of Capt. Williams in 1845, the Act of Congress in 1846 granting lands to the state of Wisconsin for the purpose of improvement of the navigation, which brings it to the period previously alluded to, the history of the operations since having been told in the NEWS of Aug. 19. This chapter is interesting as giving the progress of the various works.

From 1848 to 1859 inclusive, $1,157,784.30 was spent mostly on the Fox river. Among the items we notice that it was suggested that Congress authorize the increase of the navigation of the Lower Fox to 12 feet, in order to make Lake Winnebago a naval station, to obviate the "treaty of 1817," "but the committee regarded the treaty as practically covering the case." An abstract is given of the report of Maj. Suter on an examination into the condition of the works on the lower Fox in 1866. The works on the lower Fox are found in a tolerably fair condition, all the locks but one being 160x35 ft. and designed for four ft. draught. There are 10 dams and 18 locks on this division, overcoming an elevation from Green Bay to Lake Winnebago of 170 feet in a distance of 37½ miles. The estimate for securing 4 ft. draught through locks 160x35 ft. is $118,400; and for 6 ft. through locks 220x35 is $493,370. The Upper Fox and the Portage Canal are not found in as good condition. The distance from Lake Winnebago to the Wisconsin River is 107½ miles, the rise 42.6 ft., and the estimate for four feet navigation in the smaller locks is $326,022, and for six feet in the larger is $735,095.

Of Lake Winnebago 15½ miles is utilized. This lake seems remarkably shoal, the "depths varying in the deepest parts from 12 to 25 feet." Maj. Suter's examination of the Wisconsin was simply cursory and of no great value in view of the later surveys. We will state here that the distance from Portage to its mouth as determined by the survey of 1867, is 118½ miles, and the total fall 178 ft. The Portage summit is thus 212.6 ft. above Lake Michigan, and the Mississippi at Prairie du Chien 34.6 ft. above Lake Michigan; according to the report of Mr. Gardner, Geographer of Dept. Interior, Lake Michigan is 589 ft. above the sea. The total distance from Green Bay to Prairie du Chien by this route is 279 miles. The various improvements on the Upper Fox have shortened the original length of that part of the route by 3-5 of the original distance.

In reading this chapter, although the information in regard to the Fox rivers is amply full, one is struck with the paucity of information in regard to the Wisconsin up to 1866. Although in the midst of populous and civilized communities, less seems to have been known of it than is now known of the River Nile from Khartoumm to the Albert Nyanza; and we suspect that the absence of knowledge in regard to the habits and functions of this sand-laden river has, more than anything else, led to temporizing expedients which have entirely failed except in spending the money appropriated. We believe it was Sir John Rennie who said that rivers were made to feed canals, and it seems the wisest conclusion in this case and one to which Gen. Warren comes in the two succeeding chapters on a conscientious and exhaustive review of all the facts.

Chapter IV. gives a description of the survey of 1867 and the supplementary surveys of '68 and '69. These surveys were entirely confined to the Wisconsin valley and were very thorough. Gauges were established at various points, careful soundings were taken along the main channel and the important side chutes, the sand bars were studied, the shore lines of the river, islands etc. and the adjoining topography carefully delineated to the first sand terrace, and the whole valley to the limestone bluffs on either side sketched in, frequent cross sections being run across the valley from bluff to bluff; 415 miles of transit and compass lines were run, 122 miles of levelling, and 375 miles of soundings. The notes were plotted on a scale of 200 ft. to the inch, forming 24 sheets of 10 ft. length each. The maps accompanying the report are reduced to a scale of two inches to the mile and include a general map and profile six miles to the inch, and a sheet of gauge curves. The physical results are embodied in tables of rainfall, temperature, volume of discharge declivity, cross-section, etc. The geology and climatology of the region is treated.

"The valley of the river from Whitney's Rapids to the Dalles is mainly a broad expanse of sand." "It is probable that this was formerly a lake-bed before the gorge of the 'Dalles' was cut through." "The waves of such lake must have continued to abrade the sandstone, and to spread the sand over the bed through which the Wisconsin now flows." The bed of the river lies in this sand rock, which is quite friable, to its mouth, the tops of the bluffs of magnesian limestone being elevated from 300 to 400 ft. above the river. The "Dalles," 20 miles above Portage, is a narrow gorge through the sandstone rock about five miles in length, and 54 feet wide in the narrowest place. This contraction restrains the floods to such an extent that they seldom exceed 10 ft. below, while "they are said sometimes to rise 50 ft. above low water in the valley above." The valley is from 8 to 12 miles wide in the neighborhood of Portage, narrows to 3 miles at Dekora, and varies thence from 1 to 6 miles to the mouth. Terraces from 10 to 40 ft. high of modified drift, although not continuous, form an important feature of the valley.

The marginal lands and islands called "bottom-land" from 3 to 6 ft. above low water, overflowed at high water, slope away from the banks terminating at the terrace in lakes, sloughs, and marsh. Where not covered by sloughs or marsh they are densely wooded and filled with underbrush. The islands divide the river often into several distinct channels more than doubling the length of shore line. The width of the flood plain is from ¾ to 3 miles, and the windings of the river only increases its length by about 15 per cent. over that of the flood plain, which in itself is very direct, and nearly that of the valley.

Gen. Warren says:—"This directness of flow is a peculiarity of clear-water streams with sandy beds and high slopes. In muddy streams with low slopes it is not an uncommon thing for the meanderings of the river to be double the length of the flood-plain. There seems to be a relation between these two cases pointing to a common cause and effect. The banks of the muddy stream having more firmness cause the river to scour the bed and preserve a single channel, while the gradual yielding of the concave bends increase the curvatures and folds, and thus establishes resistance by increased surface of friction, and by diminishing the slope as the course lengthens. In the case of the sandy stream, the banks yield more readily than the bed, and thus the stream spreads and islands form on dry sand-bars dividing the river into separate parts. This increases the frictional surface and diminishes the velocity until a limit is reached. One accommodates its bed to slope and volume by lengthening, the other by widening. The water of the Wisconsin is very free from sediment, and at ordinary times quite clear, with a tinge of amber color from decaying vegetation."

In the practical point of view the sand bars are the most important feature, and are numbered by hundreds. They were noted by the first explorers and have never ceased to attract attention. From the manner in which Gen. Warren describes them, it seems quite clear that they can never be managed by any ordinary construction.

"The sand is moved down stream on or near the bottom. Part of it is deposited in slack or still water

where this occurs along the shores, while the greater part is dropped in the still water on the down-stream edge of the bars, in both cases to be again taken up at some future time, under varying conditions, and moved still further down."

"The most important bars are those which are formed by accessions at their lower edges. This kind of bar moves more rapidly where the current is strongest and thus the lower edge, which is the shoalest part, is convex down stream the most advanced part being where the thread of the stream is flowing. The sand is moved along the gentle slope of the upper side till the crest is reached, when it falls over and stops in the still water below. As the bar thus grows down stream, it becomes more convex, and the water alters its course gradually so as to pass the crest nearly in the direction of the normal lines. The effect of the extension is, therefore, to widen the overflow over the crest (which acts as a weir) and the bar becomes more shoal as it advances."

The farther remarks about the bars are very interesting but cannot be reproduced here. The upper surface of the bars slopes at the rate of about 0.6 ft. in a hundred, the crest having but a few inches, while a depth of 10 ft, will exist just below. These bars divide the river into pools and slight rapids. Low water frequently cuts out channels among them and improves navigation, while a slight rise is much deplored by raftsmen and boatmen, as it fills in the channels. It is believed by them that the bars rise with the flood keeping practicly the same depth over them, though Gen. Warren thinks this only partially true, they undoubtedly rising somewhat.

The Wisconsin sands forced into the Mississippi produce dangerous shoals for several miles below the junction, and damming up that river, account for the good navigation above. Near the mouth of the Wisconsin the worse sand-bars are found, the water being frequently dammed back by the floods in the Mississippi.

Opposite page 88 is an interesting map showing the former limits of Lake Winnebago, several times its present size, before it broke over the ridge at Appleton. These limits are shown by an old lake terrace and other evidence, and Gen. Warren weaves it into his general theory of a continental motion about an axis from S. E. to N, W. outlined in ENGINEERING NEWS of July 1. The old outlet of this lake was at Portage. He also speaks of several streams carrying detritus into the upper Fox ponding its waters and producing the lacustrine expanses of Buffalo Lake, Lake Puckaway, etc., similar to Lake St. Peters produced by the Chippaway river, and the pools of the Illinois produced by the entrance of detritus bearing tributaries. He also instances a probable change in the drainage of the lakes near Madison.

In chapter V. the methods of improving navigation are discussed at length. The "difficulties heretofore not appreciated" are alluded to and the canalization or rectification of the river is exhaustively treated. The hydraulic formulæ of Humphreys and Abbot were adopted and attempts made to confirm them by previous experiments at St. Paul where "everything we could fairly conclude sustained" them, while "the parabolic law of change of velocity from surface to bottom, was fully sustained."

Formulæ and tables are constructed for the proper width to give certain depths at low water, the width for four feet depth being 275 feet. To give this depth, entirely new banks must be prepared for both the high and low water banks of the river which must be curved, the low water channel passing alternately from one side to the other of the high water channel, the banks of both being protected by rip-rap, numerous cross dykes connecting the low water banks to the high water banks, except where they coincide, in order to prevent cross-scour. Such improvements have been successfully adopted on the Garonne in France, but they must be made very slowly proceeding down stream gradually as the river frees itself from sand, and are moreover very expensive, the estimates without the high water banks being nearly $10,000,000. "The progress of the works must be slow and tentative, waiting for the conforming changes of the river;" and probably the works could not be made permanent owing to the scour that necessarily will take place on so heavy a slope as 1.6 feet per mile, especially when the volume of flood reaches 60,000, cubic feet per second. On the whole he concludes that this method is quite impracticable.

The improvement by reservoirs is pronounced equally impracticable on account of cost and their doubtful utility when constructed.

The survey of the river was not undertaken with the idea of resorting to a canal, and when the conclusion was reached that it was really the only available method, Gen. Warren, accompanied by a canal engineer, walked over the entire route, map in hand, and made an approximate location on which he bases estimates. He recommends a thorough location survey. The estimates are based on composite locks 160×35 feet and a canal 100 feet wide in the narrowest place, and four feet deep. Twenty-one lift-locks will be required and three guard-locks; with the various weirs, culverts, rip-rapping, bridges, etc., with a liberal allowance for contingences, all estimated to cost $4,000,000. The additional cost of 5-feet navigation is estimated at $165,000; and the annual cost of operating is estimated at $50,000. The inner slope is to be paved when of less width than 200 feet.

With this, the report terminates and its completeness is satisfactory. With this report at hand no farther information seems necessary in regard to selection of methods. We hope the general government will see its way clear to making the necessary appropriation as soon as the radical fallacy of the wing-dams as applied to the Wisconsins, is practially demonstrated.

THE JAPANESE IMPERIAL COLLEGE.

ITS ENGINEERING COURSE.

We have lately had an opportunity to inspect the catalogue for the present year of the Imperial University of Tokio, Japan, or, as the pamphlet terms it, the Kaisei-Gakko. This institution, although founded in 1857, and gradually developed, was not reorganized upon its present wide basis until 1871 and 1873. There is now provision made for a general course in Literature and science, designed to be introductory to the special courses in Law, Chemistry, Engineering, and Physics. Instruction is also given in Technology or Arts and Manufactures. In this latter department the Japanese language is used entirely; in all the others English is or will be the tongue employed; but at present a special course in Physics is conducted in French. There are thirty-five professors and instructors and already 312 students.

We naturally turn to the statements about the course in Engineering. The faculty specially devoted to this course are James R. Wasson, late U. S. Army, Civil Engineering; Robert Henry Smith, of Scotland, Mechanical Engineering; Edmund Naumann, Ph. D., of Germany, Geology and Mining; and three Japanese assistants, one in Civil Engineering, one in Geology, and the other in French. The course is of three years duration, and, as it was recently established, there is this year only a first or junior class of six members. The studies prescribed are as follows:—First year, Higher Mathematics, Mechanics and Mechanism, Strength of Materials, Graphic Calculation, Land Surveying, Physics and French; Second year, Thermodynamics, theoretical and applied, Strength of Structures, Machine Drawing, Efficiency of Machines and lectures on Workshop Practice, Railway Surveying and Construction, Geology, Physics and French; Third year, Lectures on Designing Engines, Practice in Engineering Designing and Estimating, Hydraulic Engineering, Geodesy, and Mining. It is probable that some modifications may be made in the studies as experience dictates, but the faculty appear to have blocked out a list which will pretty effectually cover the ground. The degree given in this course is "Gakujiutso Tokugioshi," which, being translated, means Bachelor of Science.

The examination papers at the close of the term in July, 1876, are added to the catalogue and enable one to judge of how thoroughly the subjects are gone into. For example, in Land Surveying the questions are as follows:

"1. Explain the construction and mode of using the *Surveyor's Compass;* also name some of its chief defects.

2 Explain what is meant by the *declination of the magnetic nee le*, and describe some of the variations which this declination undergoes.

3. Explain any two methods for obtaining the declination and of determining a true meridian.

4. Explain the construction and some of the principal uses of a table of latitudes and departures.

5. Explain the construction of the *Plane Table* and its use in surveying.

6. Describe the *Engineer's Level* and its adjustments; the method of using it in the field, and of keeping the notes for general purposes.

7. In triangular surveying, explain the problem for *reduction to the centre.*

8. Balance the work and find the area from the following notes: Station 1, N. 35° E., 2.70; sta. 2, N. 83 ½° E., 1.29; sta. 3, S. 57° E., 2.22; sta. 4, S. 31¼° W., 3.55; sta. 5, N. 56½° W., 3.23."

The examinations in differential and intergral calculus, in mechanics, in strength of materials, etc., are up to about the same standard. The pupils are required to have a very creditable pecentage of marks on recitations and examinations in order to pass from one class to the next. In the model rooms they have or will soon obtain from England and America, testing machines of some three or four kinds, foundry patterns, models of parts of machinery, bridges, surveying instruments, slide and expansion valve mechanism, etc.

It is evident that the Japanese government is thoroughly alive to the benefits which will accrue to the nation from sound scientific training, and that they realize that they must at present look to other countries for their instructors and appliances of instruction. Seven of the officers of instruction are from America, being those in Civil Engineering, General Chemistry and Chemical Physics, English Language and Law, Natural History, Experimental Physics, and two in Mathematics; a larger number than from any other country, excluding the Japanese assistants.

It will be a number of years, probably, before the engineering wants of the nation can be supplied from this or other schools, as the extension of railways, canals, ways of communication, and schemes of water supply and drainage and all the various engineering works will call for skilled talent. The Japanese youth will have still to take subordinate positions until they have considerably enlarged their experience, and we see no reason why there should not be for a time as good openings for American engineers in Japan, as there has been for English engineers in India, and a demand for our iron bridges and other constructions. The territory of Japan is limited, but the population is numerous, well advanced in civilization, and situated favorably for commerce and its kindred activities.

TAUNTON WATER WORKS.

The Taunton, Mass., Waterworks of which we made mention several months ago, have recently been completed and tested, and the inhabitants of that city are rejoicing over the complete success of the improvement.

The Holly System was adopted by the board of water Commissioners, and contracts for the construction of the pumping works were let to the Holly Manufacturing Co., of Lockport, N, Y., in July last; R. D. Wood and Co, of Philadelphia, being awarded the contract for furnishing and laying the necessary pipe, hydrants and stop gates. Oct. 31, the water was let in and has since been circulating through about 17 miles of street pipes necessary for the city supply. The entire cost of the works complete has been about $203,000.

The following is from the *Boston Herald*, of Dec. 3. and may be of interest to many of our readers:

"The Holly system of water supply is, in brief, this The water for all purposes of use, including domestic and fire, is pumped directly from its source into the distributing pipes, and furnished to every locality, high or low in situation, in just such proportion as is called for. By automatic mechanical arrangement the supply is regulated to the demand, and should this demand become excessive, no matter to what degree or how suddenly, it would receive immediate and favorable response. The supply being forced directly from the source into the pipes, and depending upon no gravitation from a higher to a lower plane to produce a current in them, no reservoirs or stand pipes are needed, and an enormous expense is thus cut off at the outset,—one which frequently discourages communities inclined to furnish themselves with water works. The peculiarity of being able to increase excessively the force of the circulation of the water in the pipes, renders this system of immense value as a protective agent against fires. About 75 cities and towns are now supplied by the Holly system.

Taunton has now a population of about 20,000. The contract with the Holly company provides that the latter shall insure for the city's use for one year 1,000,000 gallons of water for every 24 hours, or at that rate, and give a duty of 40,000,000 foot pounds with 100 pounds of coal. This would require about 2100 pounds of coal for daily consumption should the full demand be made. The company also guarantee a duty of 65,000,000 foot

pounds, should the call for supply be 2,000,000 gallons in 24 hours. They also bind themselves to endure certain tests. The whole system of pipes has already been tested in accordance with their contract, by a pressure of 200 pounds to the square inch. This test resulted favorably. There were also stipulated certain fire tests by which, without hindering the domestic supply, fifteen streams of water were to be thrown simultaneously from five hydrants in different localities, each stream from a nozzle one inch in diameter, and every one of them to reach a perpendicular altitude of 100 feet. This will indicate the character of the tests. The ordinary pressure actually used in the daily domestic supply at present is 40 pounds.

The following is a description of the machinery: It consists of two complete and distinct sets, one which is a Holly compound pumping engine, having four double-acting pumps connected directly with four steam cylinders, and these four steam cylinders are so connected by means of rods and cranks that they will cause the pumps to take suction and discharge water at eight equal points in each revolution of the crank shaft. The cylinders are erected on an iron frame, arched in form, with the crank shaft placed on the top and the cylinders at the base. The steam cylinders are piped so as to operate on the compound principle, one being high pressure and others low pressure, or they may be quickly changed so as to operate them all on the high pressure principle, thereby giving largely increased power for throwing an unusual number of fire streams. The second set of engines and pumps, called the "reserve set," consists of two Holly rotary pumps, driven by a high pressure horizontal steam engine. This set is designed only for fire protection, but may be used for ordinary water supply if found necessary. In fact, either set may be used for fire or domestic service, separately or together. It is also provided in the first set that one or more of the four pumps may be detached at any moment without interfering in the least with the others. The steam boilers are three in number, of the tubular variety, each five feet in diameter and sixteen feet long. One of these boilers will supply the ordinary demands for water, and it will be seldom that either the second or third will be required for any purposes. An ingenious piece of mechanism, called Holly's patent automatic regulator, controls all this machinery, so as to preserve a uniform degree of water pressure throughout the city. It is operated by the pressure from the water mains, and any change of pressure, say one or more pounds, which would be caused by shutting off or drawing water from the pipes, moves a piston within a cylinder upward or downward. This movement operates upon a steam cut-off, so as to admit more or less steam to the engines, and increase or diminish the speed of the pumps. Thus by varying the speed of the engines and pumps the water pressure is maintained with great uniformity.

THE TESTS.

Three strokes of the fire alarm at 1:30 o'clock was the signal at the pumping station to put on the rotary engines alone. The hose had been applied to three hydrants about City square, each hydrant thus having two strings, to which one-inch pipes were affixed. Six streams from these three hydrants shot at once into the air all to a perpendicular height of from 130 to 140 feet. Ten minutes later the change was made from the rotary to the main engines without stopping the streams. No difference was perceptible. The columns of water passed over the highest buildings in that vicinity. At 1:50 three strokes of the alarm added four one-inch streams, on Main street. Ten one-inch streams were now flying heavenward, all to be witnessed from a single standpoint and deluging entire blocks as they fell. At exactly 2 o'clock three strokes of the alarm was the signal for adding five other one-inch streams on Main and Weir streets. Now fifteen one-inch streams were simultaneously playing without the least perceptible change in perpendicular height since the opening of the six. By two strokes of the alarm at 2:10 the ordinary pressure was resumed, and the visible results were plainly seen in the volume of water running down the gutters and the frozen deposit on the side walks.

The contractors claim that for $600,000, they can do for New York city, and do it satisfactorily, what its government proposes to pay $2,000,000 for doing.

HAVING been favored with a reading of a letter, written by one of our leading mechanical engineers to a recent graduate of an eastern scientific institution, we are tempted to extract some sentences which may be servicable to those of our readers who are as yet young in our profession. After remarking upon the way in which the subject of a Thesis was investigated, and congratulating its author upon the strength and maturity of the production, the writer goes on to say:—

"Thanks to educational advancement, you have been led, where your predecessors, of only a single generation, had to grope. Such a paper could scarcely have been written in my young days by a student,—certainly by no one with whom I was acquainted. My way to learn was chiefly by making mistakes, not only in construction, but in reasoning. Recent developments and discoveries have left the men of my day but little to rest upon of their early conclusions, and with much to retract. You start nearly where we are leaving off,—always abating the advantage of caution and circumspection, which the old engineer buys with the price of the best years of his life. I do not believe you can adequately appreciate the advantage of such educational opportunities as you have enjoyed. Your composition speaks much for the institution, but not more, I am glad to say, than I expected to hear, for I know of its thorough organization. And let me say finally, that, with such advantages, if young America does not soon supercede old America, it will be, not from the want of power, but from lack of its proper use."

We have felt moved to add some words of encouragement, of advice and of caution, to our young brethren, but will postpone them until another time,

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THE commissioners appointed to condemn the land for the Hudson River Tunnel, met on the 16th inst. Propositions were submitted to the Tunnel Co., the salient features of which were that the Tunnel Co. must be responsible for all damages occasioned to the property of other companies; that it shall restore, if it abandons the work, everything to its primitive condition; that the tunnel must be constructed in such a subtantial manner as to admit of the erection of buildings over it by the other companies if desired; and that if the price of the land could not be agreed upon by the parties interested, the question should be decided by the commissioners. These conditions were immediately accepted by the Tunnel Co. Work on the tunnel will probably commence, Jan. 1st.

WE are enabled to lay before our readers this week through the courtesy of the author, an abstract of the valuable paper read at the meeting of the American Association at Buffalo, by Prof. John W. Langley, in which he shows that minute differences in the per cent. of carbon contained in steel can be readily detected by the trained eye, on inspection of the fracture, and that, if engineers will once decide what per cent. of carbon is desirable in the metal they propose to use, to adapt it to the requirements of the position, the manufacturer will have no difficulty in supplying the needed grade. We refer all interested in the application of steel in engineering construction to the paper in another column, where some other important points are brought out,

A brief paper in the *Journal of the American Society of Civil Engineers*, for October, 1876, by W. Metcalf, C. E., on "Qualities of Iron and Steel," refers to a portion of these analyses and results, but some very noticeable additional facts will be found in the abstract we print to-day.

THE Chesapeake and Ohio Canal Co. seems to be aggressive and evidently means to test the power of the railway company in competing for the coal traffic from the Cumberland basin. For the past year it has competed with the Baltimore and Ohio with more or less success on heavy freights to all competitive points, and with its late adoption of inclined planes and cradles in place of combined locks with heavy lifts, is able to reduce materially the time and expense of lockage. The state of Maryland is interested in the property to the extent of $14,000,000; the canal extends to Cumberland and it is extremely unfortunate that it was not extended 25 miles farther into the mining regions. To overcome this feature which has left the canal at the mercy of the competing railways, it is about to build from the Cumberland basin a series of short lines of railway to the mines. One of these lines will extend up the valley of the Potomac two miles beyond Bloomington to the mouth of Laurel Run, and will undoubtedly be built during the coming year. The state of Maryland is not likely to commit the blunder of Pennsylvania whereby that state's interest of $30,000,000 was sold to the Pennsylvania Railway Company for $6,000,000, which company to this day operates the canal from Huntington eastward. It has been remarked, "the railroad company finds it more economical to haul its own coal and freight by the canal, but other peoples' freight they put on rails and charge accordingly."

Correspondence.

Editor ENGINEERING NEWS:

Dear Sir.—I read in your issue of 9th inst., an article on the "Divining Rod"; the facts are, and have been well known *for years* among the farmers and others throughout New England. I remember when a boy 22 years ago and living in Cambridge Mass. my uncle desired a new well dug on his place and sent for a farmer a short distance off, to come and select the spot; he used the fork described in your article, cut from the *witch hazel*, and by its inclination determined the spot, sunk the well and got good water and plenty of it; the willow, and cherry I was informed would indicate equally as well.

NEW YORK, *Dec. 13, 1876.* SUBSCRIBER.

Editor ENGINEERING NEWS:

SIR—In reply to your letter of the 5th instant, requesting the rulings of this office in regard to disputed boundaries and the subdivision of sections, I have to say as follows:

In regard to disputes arising between purchasers of Government lands, as to the proper location of their respective boundaries, this office can act only in an advisory manner and before expressing an opinion in such a matter, a particular case must be cited referring to township, range and section of the public surveys.

Under the provisions of the act of Congress approved February 11, 1805, the course to be pursued in the subdivision of sections is to run straight lines from the established quarter section corners—U. S. surveys—to the opposite corresponding corners and the point of intersection of lines so run. will be the corner common to the several quarter sections, or, in other words, the legal centre of the section.

In the subdivision of fractional sections, where no opposite corresponding corners have been or can be fixed, the subdivision lines should be ascertained by running from the established corners, due north, south, east or west lines, as the case may be, to the water-course, Indian boundary line, or other external boundary of such fractional section.

The law pre-supposes the section lines surveyed and marked in the field by the U. S. Deputy Surveyors, to be due north and south, or east and west lines, but in actual experience this is not always the case; hence, in order to carry out the spirit of the law, it will be necessary, in running subdivisional lines through fractional sections, to adopt mean courses where the section lines are not due lines, or to run the subdivison line parallel to the section line where there is no opposite section line.

Upon the lines closing on the north and west boundaries of a township, the quarter section corners are established by the U. S. Deputy Surveyors, at precisely forty chains to the north or west of the last interior section corner and the excess or deficiency in the measurement is thrown on the outer tier of lots, as per act of Congress, approved May 10, 1800.

In the subdivision of quarter-sections the quarter quarter corners are to be placed at points equidistant between the section and quarter-section corners and between the quarter corners and the common centre of the section *except* on the last half-mile of the lines closing on the north or west boundaries of a township, where they should be placed at twenty chains (original measurement) to the north or west of the quarter section corner.

The subdivision lines of fractional quarter sections should be run from points on the section lines intermediate between the section and quarter section corners, due north, south, east or west to the lake, water-course or reservation, which renders such tracts fractional.

When there are double sets of section corners on township and range lines, the quarter corners for the ections south and east of the lines, are not establisheds in the field by the United States surveyors, but in subdividing such sections, said quarter corners should be so placed as to suit the *calculations of the areas of the sections adjoining the township boundaries*, as expressed upon the official plat, adopting a proportional measurement where the present measurement of the north or west boundaries of the sections differs from the distance stated on the field notes of the original survey.

Very Respectfully,

J. A. WILLIAMSON. *Com'r.*

WASHINGTON, D. C, *Dec.* 11, 1876.

Editor ENGINEERING NEWS.—In your issue of Nov. 18th, your correspondent Elhot C. Clarke says:—"Kirkwood for instance modifies Prony's formula from

$$\text{Disch.} = 38.08 \sqrt{\frac{D^5 H}{L}} \text{ to } 38.08 \sqrt{\frac{D^5 H}{L}}$$

Will you please inform me where this modification of the formula is to be found and his reasoning for the change.

J. NELSON TUBBS.

Chf. Eng. Rochester Water Works.

ROCHESTER N. Y. *Dec.* 16, 1876.

THE PUBLISHER'S GREETING.

Twelve months have passed rapidly away since we ventured upon the expensive and decidedly hazardous experiment of establishing a first-class American engineering journal. How we have succeeded we leave each reader to judge for himself, and to assist him in making up his mind we refer him to the table of contents which accompanies this number, and then ask him to consider the continued depression of business among all the classes from whom our patronage had to be derived; our own inexperience in journalism; the lack of literary co-operation of engineers and architects; the difficulty of obtaining the kinds of information we needed most, and the ever-present drawback of being new in the business. and consequently, in the opinion of the cautious ones of the community, in danger of collapsing at any moment, to their serious loss; and we think that the most prejudiced mind cannot but admit that ENGINEERING NEWS has succeeded as well as any class journal in the country, and that, to all appearances, the interests of the civil engineering profession promises to be as ably subserved as those of any other profession or business in the land.

To us the year has been one of satisfaction. We haven't made any money, and we didn't expect to; but we have awakened a genu ne interest among certain classes wh ch we think will be made manifest during the coming season, to the benefit of our subscribers,—and to the publisher,—and therefore we will commence our new volume with unabated enthusiasm and with stronger purpose to do still better than we have done in the past.

We confess that we feel especially encouraged to do our best for the patrons of ENGINEERING NEWS, for, with only a very rare exception, they are a class with whom it has been a pleasure to do business. Prompt in the payment of subscriptions and advertisements, enthusiastic in words of encouragement, and dilatory only in communicating intelligence, (which, we suppose, ar ses from the innate bashfulness of the profess on, or dread of seeing their thoughts in print), we have recogni ed in each patron a personal friend, and as such have endeavored to serve him. We have now a constituency extending to the remotest corners of this continent; our paper is on file in the principal cities of Europe, and among its subscribers are several of the leading engineers of that country, and wherever it is read it has given satisfaction so far as we have been able to learn.

We now, at the beginning of another volume, earnestly solicit the co-operation of all who have journeyed with us during the past year, and also of those who have held back, afraid either to risk a subscription, or careless and indifferent about the success of an enterprise which cannot but be of actual pecuniary value to every ambitious member of the profession which it represents. It is fair to presume that the coming volume will be an improvement on its predecessor. We have gained a larger experience; we have a better organization for collecting information; the leading engineers of the country are becoming int rested, and subjects of great interest and value are certain to be discussed in our columns; we are now publishing an exhaustive treatise on a subject of vital importance to the entire community, which undoubtedly will be liberally discussed before we are done with it; and we are negotiating for original papers on American bridge construction; on the water supply of cities and towns; on railway construction and economy, and on steam engineering; which of themselves are each sufficient for a whole year's consideration, but, brought together in one volume, giving the latest information by educated practical men, and carefully illustrated as they will be cannot fail to constitute a most valuable compendium of engineering information which no member of the profession can afford to be without.

We think we are safe in saying that we are getting into more cordial relations with the several engineering societies of the Union, and that we will be able to publish more frequent and detailed reports of meetings, and also give to our readers the benefit of the most valuable of the papers read at those meetings, with the discussion thereon. Our contract with the Civil Engineers' Club of the Northwest has already been renewed, and we hope to make similar arrangements with some of the others. Our aim is to increase the influence of the profession, to raise the standard of its qualifications, to increase its pecuniary compensation, and in every possible way to give it its proper rank as the foremost of the learned professions,—the rank to which it is entitled by reason of its genuine us fulness to the whole world.

There is another very important department of our paper, the proper treatment of which has almost baffled our best attempts, but which we propose to develop as fully as any single individual, with the experience of a years failures, can hope to do. We refer to the subject of contracting, upon which we have spent a large amount of money and time with but indifferent success. It has necessitated an immense exchange list, and an extensive correspondence, but owing to the short time that notices of "proposals to let" are allowed to run, (very few being more than one week) and to the fact that publicity is objectionable to local parties, comparatively scanty information is obtainable. We hope, however, during the coming year to organize so extensive a correspondence throughout the entire country that the very earliest information of all important contracts to be let, will be conveyed to us in time for private communication, or for publication in our regular issue, or in extras issued to interested parties. We hope therefore that our numerous patrons who are interested in this department of our journal will feel that we are going to do our "level best" for them.

The foregoing are a few of the considerations which we desire to urge upon those who have either been reading their own or somebody's else ENGINEERING NEWS, and we hope that not one of the former will drop out of our list of subscribers, and that every one of the latter will fall into rank, and help. Do not let the only weekly engineering newspaper in America lack for a generous support, but with a genuine *esprit du corps* see to it that it is encouraged to be a fitting representative of the noblest of the professions.

To all our readers, whether they stay with us or not, we wish a Happy New Year, with a speedy return to the "better days" which are, even now, sure not to be far away.

BETTER MEANS OF EXIT FROM PUBLIC BUILDINGS.

The public seem to have been thoroughly aroused, by the late horrible disaster at Brooklyn, to the necessity of better securing audiences in our large public buildings against the dangers which attend upon a fire or a panic. A good deal of vigilance has been displayed by the officials of this country in the way of inspection, but it has been remarked that there is a strange unanimity in their reports, to the effect that the provisions for egress, in the places examined, are adequate. If this is correct we are much better off than we supposed; but we are inclined to think that such statements may come from a lack of consideration of all the necessities of the case, or possibly, as has been hinted, in some cities, from a formal examination and complimentary reports.

In order that rules for the proper provision of brick walls, ample doors, wide halls and stairways, fire-proof construction, iron curtains, water pipes, hose, etc., shall be obeyed, heavy penalties for failure to obey, and a stringent supervision by building inspectors, are needed. Our architects are competent and willing to make designs which shall efficiently carry out these plans, but they will be met by the desire for economizing in first cost by the builders, unless it is made by law too expensive for them to attempt to save in this way.

In other countries we sometimes see the advantage of what is called a paternal government, in the satisfactory way in which the public welfare is looked after, in spite of what private interests may think will answer as a makeshift No temporizing policy is wanted. The Lord Chamberlain of England, for instance, the officer who has special supervision of the theatres, has notified the theatrical managers that all violations of the rules concerning facilities of exit from places of public amusement will be prosecuted with the utmost rigor.

What is thought on this subject by a man of the most extensive experience is best stated in an extract from the *Boston Transcript* with which we close:

PRECAUTIONS IN THEATRES.—VIEWS OF A LONDON FIREMAN.

Mr. Shaw, of the London Fire Brigade, has published within the present year an exhaustive practical treatise on fires in theatres, in which he indicates the principal points of safety and danger in those places. He declares that such a manner of constructing a theatre as requires entering and leaving the auditorium by a passage or set of passages through other buildings, and not direct from the street, "is one so obviously dangerous in the extreme that it must be a subject of wonder how it can ever have been permitted in any country making even the pretense of superintending the care of its inhabitants." In one country abroad thirteen feet is the minimum distance allowed between the walls of a theatre and those of the nearest buildings, and it is specially laid down that the intermediate space must be open.

One point on which this veteran fireman lays much stress is that the risks of the several parts of a building should be separated as much as possible by strong internal walls, and the fact that in a theatre there are some parts which cannot be closed off from one another, as for instance the stage and the auditorium, is what "makes the danger of such places inseparable from their very existance" Mr. Shaw would have the authorities insist on heavy walls up to and surrounding the great opening of the proscenium which should invariably be provided with a metal curtain supported and worked by steel or iron chains. Such curtains have been tried, and whatever fault may have been found with them by managers, it is evident that in the Brooklyn catastrophe they would have done some good, considering that the majority of the victims have been found to have been burned rather than trampled to death. Subdivisions of the theatre and the audience, avoidance of steeply inclined exits or sharp corners in them (except in case of stairways, where a square corner breaks the pressure from above in a panic), licensing and marking of each part of the auditorium to contain so many persons, and no more, and some fixed proportion of the number of exits to the number of persons admitted—these are some of the principal points suggested by Mr. Shaw.

SPECIALLY FOR LAND SURVEYORS.

For several months so little space has been given in our columns to the consideration of questions of land surveying that some of our friends in that department of the profession feel that they have good reason to make objections and some even to discontinue taking the paper for another year. We cannot do more than put the table of contents in evidence of what has been said upon surveying subjects within the year, and an examination of that will reveal the fact that there has been more written than at first sight may appear. We have no excuses to make, however. We started out with a surveyor's paper and for two years labored faithfully in the attempt to gain a subscription list. We printed large extra editions of numbers which we considered of special interest to surveyors, and sent them to nearly every county in the western land states; we went through the whole list several times with circulars, and employed every device we knew of to induce the western land surveyors to subscribe for a paper devoted to their interests, going so far as to place the price of our second volume at a nominal figure so as to conform to the pressure of the hard times. We got a good deal more than our labor for our pains, but that "good deal" was an indebtedness that had to be paid off from other resources than the proceeds of the paper. Publishing a surveyor's paper was an up-hill business all the time. The profession is a poor one and only a very few of its members care to read anything; there is no business patronage worth solicitation and we could not induce an advertising solicitor to look at the paper, and we couldn't come within a rod of any business man to solicit his advertising patronage. After Gurley has supplied them with a compass and Gunter's chain, and they have got a few dollars worth of cheap instruments, what more do they ever buy? And the same objection met us in starting out with our weekly. A mathematical column, and a diagram of a section with a half page of matter on surveying were sufficient to bar us out most effectually from business men. So we had to drop the subject for the time being or give up publishing our journal altogether. And that is why we "have departed from the original scope of the paper," and if any other person is ambitious of publishing a journal for surveyors only, we hope he will succeed.

But after all, ENGINEERING NEWS was the first and only publication that ever noticed this class, and during the past year they have not been entirely neglected. Moreover we believe we have a large proportion of the most intelligent surveyors in the country on our list and it is not our intention to ignore them. Almost every engineer is interested to a certain extent in common surveying, and there are many interesting problems in connection with the practice of a city surveyor which

we hope to give to our readers within the ensuing year. At the same time we think that every ambitious surveyor should endeavor to get beyond the alphabet of his profession, and after he has settled upon how *he* is going to determine the center of a section, he may find it to his future advantage to be able to run a transit or a level, to lay out a railroad curve, set grade stakes and calculate the contents of a cutting or an embankment; be able to give an intelligent opinion as to the location and construction of a public highway and to design and superintend the construction of a highway bridge; and in this way develop into a civil engineer. And in pursuance of this object we do not know of a more efficient method of gaining a theoretical knowledge, except by attending an engineering class, than by the weekly study of ENGINEERING NEWS. We would say, therefore, to the dissatisfied ones of our surveying brethren that the way to get information on the subjects of interest to them is not to discontinue taking the only journal that ever mentions them at all, but to give it a heartier support than ever and by becoming its liberal supporters merit the attention that would have to be accorded them.

SAN DIEGO HARBOR.

In contemplation of the not distant completion of the Texas Pacific Railway, the San Diego *Union* gives an interesting article on the harbor of San Diego, an abstract of which may be of interest. We notice in this connexion that the surveys from Ft. Yuma west to San Diego are about completed and the early construction of that portion of the line assured.

Prof. Davison of the U. S. C. S., in charge of the Pacific Coast, in reply to a letter from the San Diego Chamber of Commerce says:—

My opinion, founded upon personal examination, and upon study of the Coast Survey Charts, has been on record in the "California Coast Pilot," published by the U. S. Coast Survey, for the last fourteen years, and I have had no reason to change it in the different editions, before answering your direct questions, I extract the general opinion referred to: "Next to that of San Francisco, *no harbor on the Pacific Coast of the United States approximates in excellence the Bay of San Diego.* It is readily distinguised, easily approached, and a depth of twenty-two feet carried over the bar." This depth is at the average of *lowest* low waters.

In reply to the direct questions he says:—

1. There is a depth of twenty-two feet of water on the bar at the mean of the *lowest* low waters. The average rise and fall of the tides is three and seven-tenths feet. The average rise and fall of "spring tides" is five feet; the average rise and fall of "neap tides" is two and three-tenths feet. The width of the channel over the bar carrying the foregoing depth is six hundred yards. The distance across the bar is between one and two hundred yards.

2. It compares very favorably with other bars on this coast. On San Francisco bar there is a depth of 5¼ fathoms; on Humboldt bar generally over 3 fathoms, but sometimes not over 15 feet; on the Umpqua bar 12 to 13 feet; on Coos Bay bar 7 to 12 feet; on Columbia River bar 4½ fathoms; on Shoalwater Bay bar 4½ fathoms. All these change much, except that of San Francisco, and although the Columbia River bar has more water than that of San Diego its advantages are partially counteracted by the heavier swell and greater difficulty of running in by the land marks.

3. The depth of water on San Diego bar compares favorably with the depth on the entrances to Atlantic harbors, Boston has about 18 feet; New York, 23½ feet; Philadelphia, 18½ feet; Charleston, Mobile and New Orleans, less than 18 feet.

There is a noteworthy fact in relation to the depth of water on the bar of San Diego Bay: a comparison of the surveys of Dalrymple in 1782, and Vancouver in 1793, and the last U. S. Coast Survey examinations, *shows no change to have taken place since the former date.*

4. The bottom is uniformly good. *No rocks have been discovered in the Bay or approaches.* The position of San Diego Bay with relation to the coast, and of the bar with relation to Point Loma is such that there is rarely much swell on the bar; in Summer there are not many days of heavy southeast weather. *As a rule, there is less swell on this bar than on any other bar on the Pacific Coast.*

5. I consider the approaches, the channel, and the facilities for entering and leaving, good, at all ordinary seasons, for all vessels not drawing over twenty feet of water; and at high water, for vessels drawing twenty-two feet.

6. *Large* vessels can go about seven miles (geographical) up the Bay—reckoning from Ballast Point—with an average width of channel of eight hundred yards between the four fathom lines, at *low* water. This indicates a sufficient capacity to accommodate the wants of a large commerce,

7. *There is less rain, fog, and thick haze, and more clear weather in this vicinity than all points to the northward*, and the entrance is less difficult to make and enter on that account.

Admiral Rogers in 1870 said, "that San Diego harbor was amply capacious to accomodate twice the present commerce of the Pacific Coast."

These remarks have been called out by the interest some parties seem to take in disparaging San Diego harbor, and lauding the harbor of Guaymas on the Gulf of California, in the hope of deflecting the Texas Pacific to the latter point. It is quite true that Guaymas is nearly 200 miles nearer eastern points than San Diego, but is unfavorably situated in regard to Pacific coast and foreign commerce, and has the additional disadvantage of lying in Mexican territory, although a line of easier gradients could be constructed thereto.

The harbor of Guaymas, according to Gen. Palmer of the 35th Parallel, Pacific Railway Survey, "is not large enough; posessing an area of only one-half square mile of water over 4 fathoms in depth."

No remarks would seem necessary on this point, had not Central Pacific interests seemed to constantly oppose and misrepresent San Diego as a railway terminal. Latterly they have taken the "bull by the horns" and we premise, that when the Texas Pacific or Southern Pacific is completed, the western division of the line will be found under the same control as the Central Pacific.

WATCHMAKING BY MACHINERY IN AMERICA.

An address, extremely interesting to all Americans, and flattering to our confidence in the adaptation of machinery to the performance of accurate and delicate work, was made, on November 14, at la Chaux-de-Fonds, by M. Edouard Favre-Perret, a member of the International Jury or Watches of the Exhibition at Philadelphia, on the situation of the Industry of Watchmaking in the United States.

He appears to be distinctly impressed with the perfection to which the manufacture has been brought, and the hoplessness of there being any demand for Swiss watches in this country. He traces the rapid increase in the production by the American Watch Company, at Waltham, Mass., from 15,000 in 1860 to 250,000 in 1875; he refers also in complimentary terms to the factory at Elgin, Illinois; he comments upon the extreme accuracy which has been reached by the use of machinery, so that, even by postal card order, a missing or injured part in a watch may be replaced with certainty; he shows how little adjustment and regulation the completed watch requires, and finally, what is a natural consequence of this method of production, draws attention to the lowness of price at which reliable timekeepers can be profitably put upon the market. Not only have the Swiss, as he thinks, lost completely the American market, but also our manufacturers are already pushing their sales in European countries, where even those few, who were really informed as to the progress which had been made in this country, believed that their business was secure. He calls the earnest attention of his brother craftsmen to this matter as of vital importance, but does not appear able to suggest a remedy. Although he thinks that they have no fear of competition in the more complicated varieties of watches, perhaps, under the spur of a sufficient demand for such grades, he may see new developments in this direction.

To quote his words:—"It has been said, and it has been complacently repeated, that the Americans do not make the entire watch, and that they are dependent upon Switzerland for several parts of the watch. This is a mistake. The Waltham Company make the entire watch—from the first screw to the case and dial. It would even be difficult for them to use our products, so great is the regularity, so minute the precision with which their machines work. They arrive at the regulation of the watch—so to say—without having seen it. When the watch is given to the adjuster, the foreman delivers to him the corresponding hairspring, and the watch is regulated."

The *Engineer* some weeks ago contained an editorial depreciating and finding fault with the Centennial Exhibition. The article was a bad specimen of British growl. The closing inquiry was, if we recollect aright, what good has the exhibition been to any one, what information has one gained, etc. *Engineering* gave a satisfactory reply to the article, and we might point to the statements of M. Favre-Perret, as confirming their judgment of its utility. In labor-saving and novel machinery we have always considered that the inventive Yankee mind came out strongest. As to how other nations have profited by such contrivances of ours, we remember a parallel case where our method of making arms was found superior, and a full set of gun machinery to produce weapons with exact and interchangable parts was made in this country for the English government.

THE DETROIT TUNNEL.

This subject is again called to our attention by an article in the Detroit *Post* of the 24th inst.

We alluded to it at some length in our issue of July 1st, and again on July 22d, and hope our readers will not consider it needless repetition to refer to what we then said.

On July 1st we spoke of the bad faith with which the railway companies treated the tunnel project, inaugurated some three years since, and then so far advanced as to demonstrate its feasibility in an engineering point of view; and of the policy of the railway companies in giving out the impracticability of the tunnel scheme and ever since strenuously advocating the construction of a low bridge.

At that time considerable interest was manifested by the citizens of Detroit in regard to a tunnel as opposed to a bridge, and many plans, including the carrying out of the original tunnel design, and the subsequent and most excellent plan of D. Farrand Henry, Engineer of Detroit Water-works, were reconsidered. At the same time, Gen. W. Sooy Smith, a prominent and well known engineer, whose specialty has been largely the sinking of deep foundations by the pneumatic process, and to whom the chief development of that process in this country is due, addressed a communication to the Common Council of Detroit, and entered into negotiations with a committee of the council appointed for that purpose. The following extract from a letter to the committee explains his proposition:

"If the committee of the Common Council appointed to look into my plan and proposal for building a tunnel so desire, I will visit Detroit and confer with them on the subject. My plan has never been explained to any one, and I will make the proposal in such shape as to make such explanation unnecessary except as to the final result, which shall be a tunnel under the Detroit River at any point that may be found best at or near the city of Detroit, which shall be of sufficient capacity and unquestionable strength and durability. A reasonable price (to be agreed upon in the beginning) to be paid me only when the work is completed and ready for use. I will furnish bonds in the full amount of the price fixed for the faithful performance of the work, and I don't think the cost of the tunnel will much exceed that of a first-class double-track bridge. I am willing to submit my plans confidentially to a board consisting of say five of the ablest engineers in the United States, such board to be nominated by the American Society of Civil Engineers."

This proposition which was afterwards reinforced by a conference, was very favorably received and as a result we noticed [in our issue of July 22nd] that a new committee had been appointed, consisting of the mayor, comptroller, five alderman and five prominent citizens, to confer with the railway companies and interest them in the project. These conferences have not been entirely satisfactory, resulting in what might be called a "stand-off."

The present revival of interest in the subject is due largely to the recent unprecedented cold snap which blockaded the river quite completely for nearly a week, rendering "the absolute necessity" of some more economical and reliable method of crossing very apparent. Great trouble and inconvenience has resulted to the passenger traffic, and the accumulation of freight on either side has been annoying and embarassing in the extreme. Although the trouble is greater than usual it is well described in our issue of July 22nd:

About 630 cars per day cross the river at Detroit, the transfer being effected by three ferry boats which are frequently in arrears. This is particularly so in the winter season when the boats are not only obliged, oftentimes, to cut their way through solid ice, but the ferry slips in the absence of the boat, are frequently filled with pack-ice to a depth of eight or ten feet,

In the same article we also spoke of the prospect and the arguments for the construction of a tunnel at or near Amherstberg in the interest of the Canada Southern Railway, of the effect said tunnel would have

on Detroit and the prospect of its not being built, at least for many years provided it was forestalled by one at Detroit.

Premising that the reader is already sufficiently acquainted with the status of affairs up to the present time we return to the *Post's* article.

It says this in favor of the tunnel project,—"that all parties can be united upon it, while the bridge project provokes active and determined opposition;" that "the engineers have settled it that a tunnel, even upon the plan already begun, is perfectly feasible;" and that "the parties who had charge of that work persist in declaring their belief that it can be completed within the estimate, which was $2,650,000." After referring to the affection of the citizens for the original project it says that there may be some other plan,—"which would be cheaper and serve the purpose equally well."

"The tunnel proposed by Gen. W. Sooy Smith has never been critically examined by the engineers. The proposition which he made was as fair as could be desired. He pledged himself to secure the approval both of his scheme and his estimates of cost from a board of the best engineers of the country, and then to furnish his own capital and complete the work, provided he was given a guaranty that the tunnel would be taken off his hands at cost when it was completed and in running order. In private letters to citizens he has practically renewed the offer, saying that he had not much doubt that he could still command the capital with which to build the tunnel."

It states that the committee, appointed during the summer, will at once take active measures, looking to the early inauguration of the enterprise, and ends with the usual peroration to good citizens of the metropolis and of the state of Michigan,

We have this much interest in the project;—we desire to see a tunnel in place of a bridge, the construction of a bridge being a great public misfortune. The tunnel is entirely feasible, it is everywhere recognized as a great desideratum, and we believe the plan of Gen. Smith the cheapest yet proposed and the most desirable when completed; more desirable than any other for its shortness, and lighter gradients. Again it is of paramount interest to the people of Detroit and the railway companies because they are to assume no risk in its construction, provide no capital until completed, and then not unless it is completed to their satisfaction, and the cost to be not much, if any greater than that of a good bridge.

We understand that the joint committee of citizens and "city fathers" will meet this week (we write on Wednesday) when Gen. Smith will renew his proposition, the English capitalists, who are to furnish the money to build the tunnel provided his plans are adopted, having given him additional assurances.

Acquainted as we are with the works of Gen. Smith, and his ability to cope with the difficulties attending the founding of structures in deep water and on bad bottoms, we cannot but advise the committee to consider well his proposition, submitting his plans to the most rigorous examination before a board of eminent engineers and satisfy themselves in every respect of their feasibility.

The committee we believe are inclined to consider favorably his eminently fair and to them advantageous proposition, and we hope, and it looks so now, that the solution of this long-standing problem will not be long deferred.

REPORT OF THE COMMISSION ON THE MISSISSIPPI JETTIES.

We have received the report of the commission on the works for the improvement of the South Pass of the Mississippi River. This commission consisted of J. G. Barnard, Col. of Engineers, H. G. Wright, Lieut. Col. of Engineers, and B. S. Alexander, Lieut. Col. of Engineers, and was appointed by the Secretary of War on November 2d, 1876, with instructions to proceed to New Orleans to report upon certain questions in the main as follows:

First, Is the shoal at the head of the South Pass a part of the main Mississippi river, and is Capt. Eads entitled to the first payment of half a million dollars when a 20 ft. channel is obtained exclusive of this shoal? *Second*, What depth and width of channel is it desirable to obtain through this shoal? *Third*, What is your interpretation of the words "average flood tide?"—the secretary here refers to the decision of the Chief of Engineers from which Captain Eads has appealed. *Fourth*, your opinion in regard to the materials, workmanship, etc., of the jetties, and whether the work is being constructed according to the spirit of the act of Congress. *Fifth*, Any general suggestions which will assist the Secretary of War in the performance of his duties.

The commission proceeded to New Orleans and examined the works and reported from that place on Nov. 19th. They replied seriatim to the questions of the Secretary as follows: *First*, the shoal is common to the three passes, but the channel through this shoal, which has been had or is to be had, is a part of South Pass, which construction they believe to be in harmony with the views of the commission of 1874, and that the United States is under obligations to pay when a channel 20 ft. deep and 200 ft. wide is obtained "between the South Pass of the Mississippi river and the Gulf of Mexico." *Second*, Section 4 of the act demands a navigable depth through this pass, "and of course through this shoal," of 20 ft. within thirty months, and an additional depth of 2 ft. per year until 26 ft. shall be secured. These depths are deemed satisfactory and are fairly equivalent to the greater depths demanded for the "wide and deep channel connecting the Pass with the Gulf of Mexico." All the demands of commerce will be satisfied for a time by a channel through the shoal of less width than that contemplated by the act. This would require a bottom width of 200 ft. which "is somewhat greater than is *now*" [italics our own] "to be found in reaches of considerable length in the body of the South Pass itself, below Grand Bayou." This is "recommended as a desirable width to be secured." *Third*, they consider the principle advanced by Gen. Comstock, and endorsed by the Chief of Engineers, that "the mean of the high waters of the rivers at this place (the head of the Pass), taken from one or more lunations when the river is at what is known as its low stage" be the "measure of depths prescribed," and that Gen. Comstock's provisional zero be revised in accordance with this principle. They recommend that, as the zero at the Gulf end "is so nearly correct," it be not altered as it would involve confusion in the comparison of future soundings. *Fourth*, they "find that in general plan the jetties of Mr. Eads correspond substantially with those designed by the board" (of 1873). They add, however, that this design was not obligatory, being largely tentative. The jetties, except near the ends, have resisted well. The mattresses "are denoted much inferior to those of the Dutch," and much less stone has been used in sinking them than would have been used by government engineers, working under appropriation. Still they believe "that the work is being constructed essentially according to 'the spirit of the act.'" They deem "an enlargement of section and a larger application of stone to be essential to security," at the outer ends. *Fifth*; they believe that "not only an enlargement of section, but a larger application of stone to be essential to the security of the jetties, their sea ends especially, and we are of opinion that this enlargement of section and consolidation throughout, by the application of stone should be undertaken at once, and a reasonable progress therein be made the condition of the second and all future payments." "The present works at the head of the Pass are mostly of a tentative and temporary character, and as their proper positions are determined, should be replaced by substantial and permanent structures, to be completed before final payment is made."

From the report of the Secretary of War, we learn that on Aug. 7, the maximum draught which could be taken through the channel between the jetties on that date was 19.8 ft., and over the shoal at the head of the Pass 13½ feet. A telegram from Gen. Comstock bearing date Nov. 18, states that a draught of 20.3 ft. could then be carried through between the jetties but that for over 2000 ft. of its length this channel is not 200 ft. wide; and that at the head of the Pass there is a channel from 30 to 90 ft. wide through which 18½ ft. can be taken. He refers to the report of the commision, outlined above, and expresses it as their opinion that "unless Eads and his associates secure a depth of twenty feet entirely through the pass, before the 3d of September, 1877, Congress may revoke their grant." In order that there may be no question on either side he has submitted the case to the Attorney General for his opinion. Should certain views be sustained it will probably be his duty to notify Congress that $500,000 will be due by February, 1877, and that "the sum of $1,000,000 may possibly be required for further payments dur the next fiscal year."

The most that can be gathered from these reports is essentially confirmatory of the views previously expressed in this paper. Comparing the results, so far as they can be compared, with previous results, it seems that no substantial progress has been made in securing a better channel for the past six or eight months. We judge that the scour has largely ceased and an equilibrium point reached, the pass accommodating itself to the new regimen. If this be true, the tendency is to silt up the pass until it presents a uniform cross-section throughout, probably somewhat greater than the present section through the jetties. Whether this tendency can be reversed by the auxiliary works and dredging at the head of the pass, and its permanent decay into a bayou prevented, remains to be seen. The solution of the problem is now well advanced, and we trust it may result entirely in the favor of the enterprising projecto.

SANITARY ENGINEERING is omitted this week in order to make room for the Table of Contents.

MUCH wire-pulling and other mysterious work has been going on for the past few weeks in the courts and in regard to the Sexton contract for the iron-work for the new court house. It appears that McNeil & Co., who obtained the contract for the stone last summer, which we noticed at the time, at something over half a million dollars, is generally regarded as the "stool-pigeon" of Edwin Walker *et al*, and working in the interest of a certain clique who desire to obtain control of the entire court house job. Accordingly their bid, which was the lowest "responsible" one, was rejected for that of Sexton, some $13,000 greater. Sexton is generally regarded as an upright individual, a good workman and not addicted to "extras',' and the board has accidentally performed a good act in the exercise of its discretion in giving him the bid.

SAN FRANCISCO has been troubled the past season in its lower wards by the prevalence of small-pox and latterly by diptheria and other zymotic diseases incidental to bad drainage, water supply, etc., and the city papers are making an outcry against the evil, adducing the fact that the sewers in the lower levels of the city are subject to the fluctuations of the tide and period cally converted into "elongated cesspools," at the same time forcing the gases into the houses. This subject should be agitated until there is not a death reported in any city of this land from zymotic diseases; the whole class has been carefully studied, their causes made known, and the remedies in ready reach of our municipal authorities. San Francisco is by its position one of the healthiest cities in the land, and a due attention to sanitary measures will undoubtedly remedy the ills complained of.

THE Prismoidal Railway commencing at Norfolk on Sonoma Creek, Cal., is completed 3½ miles toward Sonoma, and was opened for trial on the 25th ult. The prismoid is of wood, built up of beveled boards in continuous prism, 27 inches wide at the base and 15 inches high, with the single rail laid on top. The cars and engine are mounted on two wheels each and ride the rails much like a bicycle. At the appointed time, the train, consisting of engine and flat-cars, moved off smoothly, with but slight oscillation, these oscillations decreasing as the train acquired speed until the train rode the "single rail as firmly as the trains on the broadest of English solidly constructed broad gauges." The construction of the road has cost for the present 3½ miles about $4,500 per mile including the extra cost of the road-bed over the marsh, or about half the cost of the narrow gauge systems. More details in regard to the operation of this eminently singular railway would be of great interest in order that engineers may decide on its merits for certain locations. As this experiment is being pushed rapidly to completion no doubt we shall soon be in possession of ample data.

IT is with considerable satisfaction that we offer for sale this week Prof. Greene's very valuable contribution to architectural and engineering literature—"Graphical Analysis of Roof Trusses," which is advertised in another column. The method of presenting

the subject is so simple and plain, that it is especially adapted to that large class of practitioners who are deficient in the mathematical knowledge necessary to the theoretical calculations of all the parts of a roof or bridge truss, while at the same time it gives to the most learned of the profession a rapid and simple method of testing the accuracy of their analytical processes. The work was published early in the year in ENGINEERING NEWS, but its publication in book form has been unavoidably delayed till now. A large number of copies have been ordered for some time past, and we predict a liberal demand for the work from engineers and architects all over the country. The book is carefully printed on very heavy paper, is illustrated with three folding plates so arranged as to be always before the reader's eyes while studying each problem, and is bound in first class style. Being the first bound publication issued from the office of ENGINEERING NEWS, especial care has been taken in its mechanical execution, while we have placed the price at such a low figure as to insure a rapid and extensive sale.

THE regular annual meeting of the "Engineers Club" of St. Louis was held on Wednesday, Dec. 6th, at 8, P. M. at the Office of the St. Louis Bolt and Iron Co. at their request. Mr. Theodore Allen was duly elected a member of the Club.

Annual reports were received from the Secretary and Treasurer, showing a prosperous condition of the affairs of the organization, and on motion filed. Various communications were read by the Secretary, which had been received since the last meeting, and the election of officers for the following year was then held. The following officers were re-elected: President, Henry Flad; Vice President, Geo. W. Fisher; Treasurer. Wm. Wise; Secretary, Chas. A, Smith.

After a brief speech of acknowledgement for re-election the President called the attention of the club to a paper on the "Utilization of Blast Furnace Gas" by Dr. G. Klupfel, containing an account of devices for keeping the top of blast furnaces closed all the time, and of introducing the charges without allowing the gas to escape while so doing, and of apparatus for effecting such saving in heat,

Mr. S. A. Meysenburg then called the attention of the club to "Railway Joints," and exhibited the various changes made in the fish plates from time to time. The introduction of the angle bar, and its changes up to a new form known as the "Sampson Joint," which had just been brought forward. A large collection of such joints was shown, and a long discussion took place thereon. On motion adjourned.

Correspondence.

Editor ENGINEERING NEWS:—I notice with much interest your publication of Latham's Sanitary Engineering, and as you submit the question of the propriety of its publication in the manner you have undertaken, I take pleasure in giving my views, believing they will accord with those of many of your readers; and should this be the case, it would seem proper that you should be apprised of the fact, inasmuch as the publication is given gratuitously to your subscribers, and in no way interferes with or detracts from the usual and more legitimate objects of your periodical. An objection would hold, did you in publishing the work fail to attend to the regular duties and objects of your paper, but under the circumstances I think clearly not. I am unable to see why your correspondent thinks the value of your paper is lessened by reprinting this publication—on the contrary it appears to me to give it a certainly increased value. Indeed the manner of its publication is particularly acceptable to me, and I think it must be so to all of your readers who are not possessed of the work.

Your design of making it a basis of discussion, especially strikes me favorably; and in this connection I would refer to Mr. Clarke's correspondence:

Mr. Clarke complains of the disagreement of authority on the subject of velocity and discharge, and in illustration cites the formulæ of Prony and Kirkwood. As he says, the older authorities practically agree in results, and so also as to the later ones, and yet the two differ very materially. Certainly their formulæ can not be based upon the same precise conditions.

The older authorities in their formulæ give the actual discharging capacity of sewers, without reference whatever to any considerations of absorption, evaporation, or any storm water beyond a usual and proper amount to be provided for; whereas the later authorities, I think, clearly take these elements into consideration in their formulæ.

According to Roe a 3-ft. sewer will, with an inclination of 1 in 240, drain 155 acres, in a rainfall of 1 in. per hour. Now were we to estimate that all the water would find its way into the sewer, and that the same should be carried off without surcharging the sewer, it would only drain according to Eytelwein's formulæ, about 37 acres.

In following Roe in this instance, we would provide for a little less than ¼ of the rainfall, and in larger sewers the provision is still less. While these statements go to show that later authorities consider in their formulæ the conditions already referred to, they also suggest the question—Do they do so reliably?

Are we expected to fully confide in Roe when he gives an 8 ft. sewer with a fall of 1 in 480 for the drainage of 3,025 acres; with the Bazalgette formula, when according to which, the same sewer would drain 2,904 acres; and with the Brooklyn formula, when, according to which, the same sewer would drain 2,209 acres; the 1st providing for a discharge of only 1-10th of an inch of rainfall per hour, the 2d only 1-9th, and the third only 1-7th? From my own limited experience, and from my knowledge of some of the practice in the western cities, I believe that such provision for sewer discharge is not sufficient.

It would seem that the collating of the practice of our ablest and most experienced hydraulic engineers would be of great value on this subject. That from their practice a reliable basis might be obtained for a conventional amount of rainfall that sewers should be designed to carry off under ordinary circumstances. Upon this basis so obtained, members of the profession might then make their designs, making due allowance for the natural and artificial local conditions of the area to be drained. G. M. A.

HENDERSON, KY., *Dec. 16, 1876.*

Toronto Correspondence.

Editor ENGINEERING NEWS:

Within the year just drawing to its close the principal work of construction carried on in Canada are Government works, as the completion of the Inter-colonial Railway, the enlargement of the Welland Canal, the construction of portions of that part of the Canadian Pacific Railway between Lake Superior and the Red River of the North, the improvement of the harbors at Goderich and other places on the Lake, and the extension of certain colonization roads. In the construction of railways owned by companies there has been much less activity than in former years; yet in this Province —Ontario—fair progress has been made. Among new railways the Hamilton & North-Western, has been actively pushed forward, and the grading from Hamilton to Georgetown on the Grand Trunk is nearly completed. The Lake Simcoe Junction, which extends from Stouffville on the Toronto & Nipissing Railway to Port Jackson on Lake Simcoe, has been made ready for the iron for a distance of eighteen miles from Stouffville. The Victoria has been opened for traffic from Lindsay to Kinmount about 60 miles. The Whitby & Port Perry extension to Lindsay has been graded the greater part of the way. The Kingston & Penbroke has been extended to Sharbot Lake. The Canada Central has been completed to Penbroke, and opened for traffic to that town last spring. And the London, Huron & Bruce, and the Port Dover & Lake Huron were opened for traffic early in this year.

Notwithstanding the "dull times," joint stock enterprise in Ontario does not appear to be dying out. At the session of the local Legislature commencing here early next month, application for acts of incorporation will be made by several new companies. The county of York Street Railway Company, seek power to construct a street railway in that county. The Metropolitan Street Railway Co. of Toronto, propose to construct and work a street railway in this city and adjacent municipalities. (Be it remembered that the present Street Railway Co. enjoy a most profitable monopoly in this city, and opposition is much needed in the interest of the citizens.) Several existing railway companies ask for extended powers; and a number of municipalities seek power to give bonuses to certain railway and manufacturing companies. And the Canadian Industrial Exhibition Company will ask to have conferred upon it all necessary powers for the erection of buildings and the construction of other works necessary for the purposes of the International Exhibition, which it is proposed to hold in this City in the year 1879.

It is proposed to erect new parliament buildings here. Their cost will probably be not less than $2,000,000.

The Credit Valley Railway Co. is again moving with a view to asking this city for a bonus.

The promoters of the Huron & Quebec Railway Co. are actively canvassing the municipalities between Ottawa and Toronto, for bonuses to that portion of their line.

In mining but little has been done in this Province in 1876. The only observable activity has been in phosphate of lime, a considerable quantity of which was mined and shipped for the English market from Storrington and adjacent townships, on the Rideau Canal, and from Buckingham nea rOttawa. From Thunder Bay, Lake Superior, we hear cheering reports from the Silver mines. CANADENSIS.

TORONTO, 22nd., *Dec*, 1876.

NOTES.

THE solid concrete wall which the government has built for the protection of St. Anthony's Falls, at Minneapolis is 1875 feet long, 40 feet high, 7 feet thick at the base, and 4 at the top. It cost $900,000, of which over $300,000 were contributed by the private enterprise of the citizens of Minneapolis.

PROFESSOR HUXLEY, at a London lecture, recently gave some striking instances of the ill effect on public health of neglect of drainage, and showed by the case of the town of Salisbury, that consumption, which was more fatal than all the zymotic diseases combined, might be diminished as much as fifty per cent, by thorough drainage of the subsoil.

THE fine working model of the Calumet and Hecla Works on a scale of one half inch to the foot, showing the buildings with the machinery, steam engines, stamps, jigs, etc,, all in running order, and occupying some 100 square feet of floor, which was on exhibition at Philadelphia, has been presented by the company to the School of Mines, University of Michigan, and was received last week.

WE see it stated that Col. J. T. Fanning, C. E., has in preparation a volume of some 400 pages, on "Water-supply Engineering," adapted entirely to American practice. It will form a comprehensive treatise on the theory and practice of gathering and storing water for power and domestic use, clarification of water, flow of water in pipes and canals, raising of water by power, and on the practical construction of reservoirs, dams, and pipe systems for the distribution of water in cities and towns.

THE Lockport, N. Y. papers report that the curious experiment of heating the city with steam, after the same manner that it is lighted with gas, is soon to be tried. It is not thought possible to have one boiler do the job, but the city is to be divided in districts, and each district is to have its separate boiler. A good chance apparently for loss of heat and condensation. When the houses are all piped some inventive genius will be called on for a meter to register the "mode of motion" which used to be called *caloric.*

One of the hottest regions of the earth is along the Persian Gulf, where little or no rain falls. At Bahrin the arid shore has no fresh water, yet a comparatively numerous population contrive to exist there, thanks to copious springs which burst forth from the bottom of the sea. The fresh water is got by diving. The diver, sitting in his boat, winds a great goat-skin bag around his arm, the hand grasping its mouth; then he takes in his right hand a heavy stone, to which is attached a strong line, and thus equipped, he plunges in and quickly reaches the bottom. Instantly opening the bag over the strong jet of fresh water, he springs up in the ascending current, at the same time closing the bag, and helped aboard. The stone is then hauled up and the diver, after taking breath, plunges again. The source of these copious submarine springs is thought to be in the green hills of Oman, some 500 or 600 miles distant.